POWER

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Value in High Temperatures

IN HIS paper on heat insulation, presented at the Rochester meeting of the American Society of Mechanical Engineers, L. B. McMillan places needed emphasis on the value of heat at high temperature levels.

There is plenty of water in the ocean; but you cannot get power out of it, because there is no lower level for it to drop to.

Anything with so high a head, or pressure or temperature, that it has a potential fall is worth more than that which has already got down to the dead level.

There is as much heat in five gallons of sea water as there is in a pound of 300-lb. steam—but what good is it?

And just as the leakage of a given quantity of water under a high pressure is more of a waste than the leakage of the same amount under a low pressure, so the dissipation of a given amount of heat at a high temperature is more serious than the loss of an equal amount of heat at a low temperature.

It is equally wasteful to draw upon a high-pressure steam supply for purposes, such as heating and processing, that require temperatures no higher than that of low-pressure steam.

Make the steam at high pressure and temperature and work it to the required condition through an engine or turbine and you will get the resulting power practically as a byproduct.

In the days when 100 lb. was high pressure the back-pressure had to be kept down in order to get worth-while engine efficiency, and in the absence of superheat the exhaust was wet, oily and loggy.

Now boiler pressures are available that permit ratios of expansion and mean effective pressures high enough to keep down the steam rate of engine or turbine and permit it to carry a load that justifies its investment with back-pressures as high as many boiler pressures used to be.

With sufficient superheat, the exhaust may be made as dry as was steam right from the boiler, and if from a turbine it will be free from oil.

And notwithstanding the fact that high-pressure steam is so much more valuable, it costs, in heat, but a trifle more to make; some 1,200 B.t.u. for 400-lb. steam, against about 1,180 for the 50-lb. sort.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Power Development for Maximum Over-All Economy

SOMETIMES the thing that is obvious is the thing that everyone notes but no one does. That has been the case with the four-part combination between coal carbonization, process steam supply, power generation and coal byproducts production. There has been hardly a single gathering in recent years for the discussion of power or fuel problems that has not touched upon the possibilities of such a combination. The promise it holds out of cheaper power, smokeless fuel and ample supplies of materials for the chemical industry has appealed to all. But every one hesitated, waiting for some one else to make a start, so that no progress has heretofore been made along such lines.

This week's news columns of *Power* contain, however, the announcement of a great new plant to be erected in Chicago to embody this combination. The new venture, which will eventually require the investment of forty million dollars, will be based on the low-temperature carbonization of coal. Steam, electric power, fuel gas and solid smokeless fuel will be supplied to a group of meat-packing and other industrial plants. Tar, light oil and other byproducts will be available for chemical manufacturers. And, no doubt, a market for smokeless fuel for domestic purposes will soon be developed.

Development of such plants has so many latent possibilities for affecting the field of power generation that all engineers will do well to follow its progress. If electricity can be rather widely generated in plants that utilize practically all of the heat in the coal, instead of the less than one-third that is now generally recovered, then far-reaching changes are likely to follow. If, in addition, byproducts now burned or wasted up the power plant stack are recovered and put to good use, still greater over-all economy will be realized. And, finally, if a reasonably priced supply of smokeless fuel is to be made available to those who must burn fuel, then the smoke-abatement problem will be satisfactorily solved.

All these possibilities lie in the plant that is now to be built. It is to be hoped that the courage to do the obvious will be more amply rewarded than is usually the case.

Select the Power Drive As a Unit

AN ELECTRIC drive for a machine includes a motor, a controller and a means for connecting the motor to its load. The mechanical transmission between the motor and its load may be some form of coupling, a speed reducer, a variable-speed transmission or a combination of two or more of these. Motors and controllers can be obtained in a wide range of characteristics. This also applies to mechanical power-transmission equipment. These facts are frequently overlooked when selecting power drives—and the results are costly.

If a satisfactory power drive is to be obtained, it must be selected to suit the characteristics of the load. This means co-ordinating the motor, control and mechanical-power transmission to meet the load's requirements. Therefore when choosing these parts, the influence that one may have on the other's operation should not be overlooked. To neglect the fact that a squirrel-cage motor started by connecting it directly across the line applies a sudden torque to the load may prove disastrous. Such motors should not be applied to machines that have considerable backlash in their parts, nor should a speed reducer be used that will allow the starting torque of the motor to apply a sudden shock to the reducer on the load. A coupling possessing tangential flexibility between such a motor and its load may prove effective in relieving the shock at starting and make an otherwise unsuccessful drive satisfactory. The use of these motors has simplified control and reduced the cost of installation and maintenance; but these qualities may be defeated if the drive is not selected with regard for the relation of one part to another.

The influence of the power drive on the power supply should also be considered carefully. Slow-speed squirrel-cage motors have a poor efficiency and power factor. An application requiring such motors usually can be taken care of by a high-speed motor and a speed reducer or by a slow-speed synchronous motor, giving a more satisfactory drive and a reduction in the power cost.

Each job presents its particular problem and should be solved according to the conditions that exist. Among the available motors controllers and power-transmission equipment there is one combination that will give a maximum of service for the power-equipment dollar invested. To obtain this requires that power drives be selected as a unit by a competent engineer and not as a number of more or less unrelated parts by the plant's handy man, who hopes that they will work when assembled.

Large Diesel Engines in Industry

THROUGH some strange process of reasoning, engineers seem to take the stand that the large Diesel engine is not suitable for industrial power plants. At the same time, there seems to be no question about the possibilities in marine service or in central stations. The result is that while engines of over four thousand horsepower are in service in central stations in this country, and even larger ones abroad and in motorships, only in mining is use made of such engines for industrial service.

There are a number of industries where the power requirements are so much greater than the maximum amount possible to be developed from the steam needed in processes that the Diesel should receive a serious consideration, which is not given it at present.

In the paper industry competition is forcing a larger output without an increase in plant equipment. This entails an increase in the digester-steam pressure, which necessitates either new high-pressure boilers to permit bleeding at the greater pressure or the use of live steam in the digesters. Under such circumstances it is possible that the cheapest method might be to run a turbine against the digester pressure and generate the remainder with a Diesel. The cost of the Diesel will not exceed the cost of additional boiler and turbine capacity; and the Diesel's generating cost would be lower in many localities.

Other industries have similar power and process problems. In some over half of the heat developed in the boiler furnace is definitely wasted in the condensing water. The Diesel would give a favorable heat balance in many instances.

In New York State a publishing company runs a combined steam and Diesel plant with results that are fairly startling, and New York's latest hotel will use one Diesel to supplement the steam plant.

Of course, a favorable heat balance is not the whole story of any plant, but with existing coal and oil prices, the over-all costs should follow the heat balance.

Another Milestone In Engineering Education

TEACHERS of mechanical engineering, engineering leaders in industry, and "unofficial observers" who attended the recent S.P.E.E. summer school at Purdue University came away with a broader vision of the educational job. It will be recalled that this was the third summer school conducted by the Society for the Promotion of Engineering Education and the first devoted specifically to mechanical engineering.

One could not spend many days at this conference without sensing the innate mental honesty and open-mindedness of engineering teachers as a class. No other group of college teachers has stood back of a large-scale national survey of its methods and personnel. No other is so free of those ostrich-like individuals who mistake their own pet notions for ultimate truth and refuse to admit that they might possibly be mistaken.

While industry is turning more and more to the colleges for its future leaders—a fact that any one may check—the teachers are concentrating on the job of improving themselves, their methods and their product, the graduate.

Surely this is a healthy situation. In its light even a pessimist should see a glorious future for engineering education.

Steam Storage In Boilers

THE discussion of steam accumulators for peak-load service has directed attention to the possibilities of steam storage in the water space of boilers. While some of the earlier forms of boilers did offer considerable steam-storage capacity, modern conditions of operation and present-day requirements of pressure regulation are against appreciable storage capacity.

Pressure variations over a considerable range were not considered a serious matter in the early days with low steam pressures, and were permissible even with good operation. Boilers of the Scotch marine, return-tubular and similar types were used, and were seldom operated much above rating. These forms of boilers contain large water volumes, the stored heat of which furnished steam when the pressure was allowed to drop. In other words, such boilers, under low rates of driving, had measurable steam-storage capacities when considerable variation of pressure was admissible.

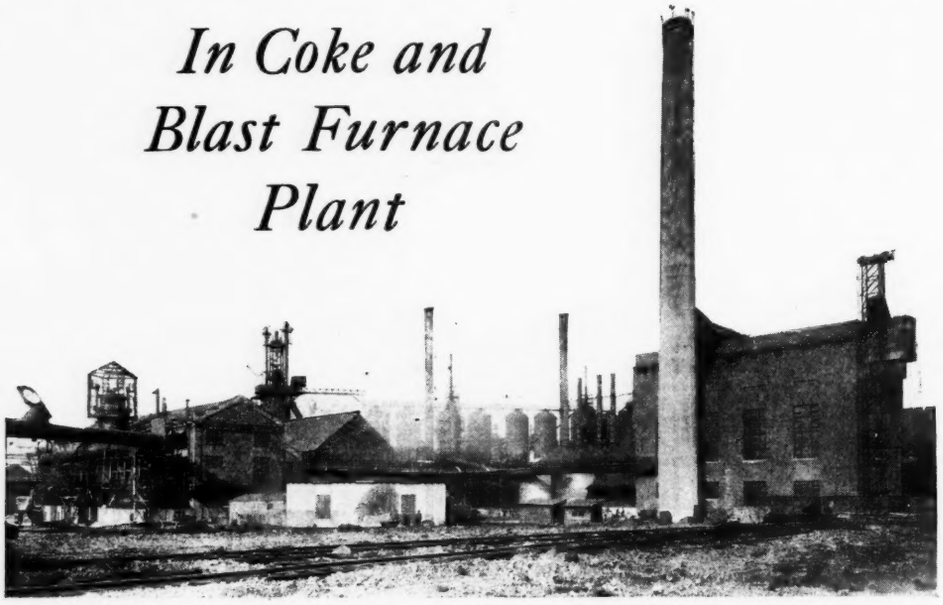
The present trend in the operation of water-tube boilers with their comparatively small water volumes is toward higher and higher ratings, and modern plant operation requires the maintenance of practically constant steam pressure. These requirements prohibit a drop in pressure that would yield any appreciable amount of steam by flashing from water in the boiler.

Furthermore, the higher pressures now generally used do not lend themselves to steam storage so well as the lower pressures. This is evident when one considers the B.t.u. per pound of boiler water that are made available for flashing from a thirty-pound drop in steam pressure with 450 pounds boiler pressure in a modern watertube boiler as against a similar drop from 130 pounds in a return-tubular boiler. In the first case only 7.6 B.t.u. per pound of boiler water are released while in the second there are 20.3 B.t.u. per pound.

The suggestion that steam-storage capacity be provided in modern water-tube boilers cannot therefore be taken very seriously. If steam storage is deemed desirable it can obviously be secured best at lower pressures in vessels that are separate from the boiler itself.

Byproduct Fuels BALANCED

In Coke and Blast Furnace Plant



TO USE SURPLUS FURNACE GAS *to generate the steam and electric power needed for both plants, or to substitute furnace gas for coal gas under the ovens, dispose of the oven gas for domestic use and purchase much of the power was the problem. Following the latter plan involved the erection of a new 400-lb. boiler house designed to burn in combination coke breeze and blast furnace gas, and new turbine blowers and evaporators.*

FOR several years the By-Products Coke Corporation has been studying the problem of utilizing to the best advantage the gaseous and solid fuels from its furnace and coke plant, located in the Calumet district of South Chicago. Blast furnace gas, coal gas and waste heat from the ovens, and coke breeze were available. An interesting solution of an intricate problem has been made, and one of the features was the design of a new boiler plant to burn simultaneously coke breeze on forced-draft chain grates and blast-furnace gas in the upper part of the combustion chamber.

In the furnace plant, located at 108th St. and the Calumet River, two furnaces having an aggregate capacity to produce 1,000 tons of pig iron per day, supplied large quantities of gas averaging 95 B.t.u. per cu.ft. As there was no direct use for this gas beyond heating the hot-blast stoves, part of the surplus was used for the generation of steam and the remainder was bled to the atmosphere.

Steam for the works was generated in sixteen Stirling boilers, with the low setting, individual steel stacks and hand-fired grates for coke breeze common to the blast furnace plant of 1905, the date of installation. Gas was the main fuel, but a bed of coke breeze was kept going to maintain combustion and to provide for irregularities in the gas supply. Monthly averages showed that gas equivalent to 9,300 tons of 14,000-B.t.u. coal, supplemented by 70 tons of coke breeze, generated 90,000,000 lb. of steam to supply six vertical cross-compound blowing engines, a non-condensing Corliss engine, direct-current-generating plant delivering 600,000 kw.-hr. per month, and a variety of pumps and other steam uses. As there was no means of forcing the boilers, operation did not exceed 80 per cent of rating, and the boiler efficiency averaged about 55 per cent. So long as one-third of the gas was being wasted to atmosphere, these inefficient conditions were immaterial, but when the fuels of the two plants were co-ordinated, it became desirable to modernize the steam-generating and steam-utilizing equipment.

The coke plant is approximately one mile from the furnaces and is separated from them by the Calumet River and by the main tracks of several railroads.

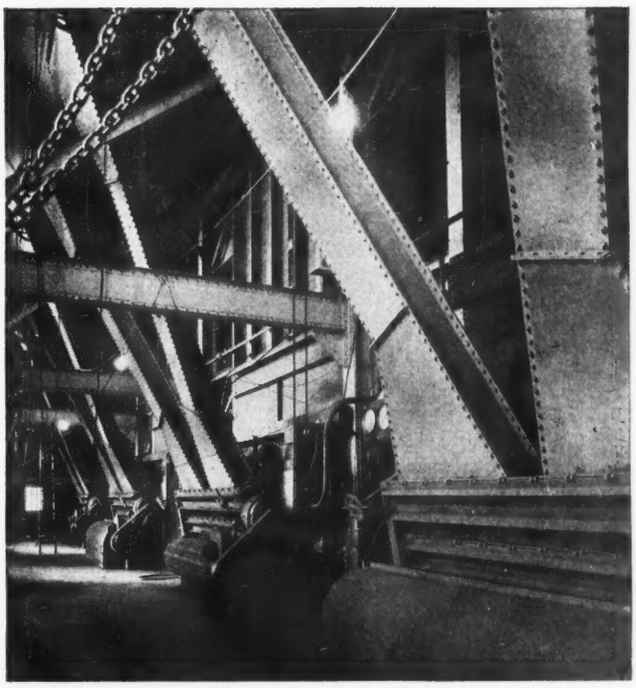
Up to 1923 the coke plant produced its own power and steam for process, with coke breeze as a fuel auxiliary to six waste-heat boilers. At that time a new boiler plant containing four 6,110-sq.ft. Stirling boilers, equipped with forced-draft chain grates for the burning of coke breeze, was erected. The Becker ovens went into operation in 1925, using gas of their own production for firing, with arrangements to deliver the surplus to the city mains.

By 1928 the increasing demand of the city for this rich coke-oven gas, containing 565 B.t.u. per cu.ft., reopened the fuel problem and brought about a comprehensive analysis of the entire power and gas situation, resulting in several major changes, chief of which was the substitution of blast-furnace gas for coke oven gas under the ovens, thus releasing more of the oven gas for domestic use. This made it necessary to transfer most of the blast furnace gas not used in the hot-blast stoves to the coke plant and to provide a new boiler plant for the

furnaces, economically equipped to burn the furnace gas that might be released by a surplus of oven gas above the contract requirements, and breeze purchased from the coke plant. Balancing the various values involved resulted in the decision to purchase current to meet the full power requirements of the furnace plant and about two-thirds of the power demand at the coke plant. At the latter location the six waste-heat boilers and the four boilers burning coke breeze have been retained to supply the large steam demand from process and the exhausters and to generate the balance of the power.

Although coke ovens have been underfired with blast furnace gas in Europe, and the economic value of the practice long has been realized, the By-Products Coke Corporation was the first modern coke plant in this country to use it in this way, and it may be said that the results have been most gratifying. A dry dust catcher, dry cleaner and a washer were already in use on each furnace, but to clean the gas more thoroughly for the ovens, five wet-scrubbing Theisen washers driven by synchronous motors were provided, as well as three turbine-compressors to boost the gas to its new point of use. Over a mile of 60-in. piping, passing en route under the river and the railway tracks, was required to deliver the gas to a 2,000,000-cu.ft. dry-gas holder erected at the coke plant.

To provide steam for blowing, gas boosting, pumping and other requirements of the furnaces the first essential was a modern boiler plant that would burn economically coke breeze and the comparatively small amount of surplus furnace gas anticipated. It has been common in steel plants to equip boiler furnaces to burn either one of these fuels individually, but to burn dirty gas, taken off before passing through the wet scrubbers, in combi-



Four 400-lb. boilers equipped with forced-draft chain grates to burn coke breeze

TABLE OF EQUIPMENT

Boilers and Combustion Equipment

Boilers, 4, cross-drum type, 6,400 sq.ft., 450 lb. pressure	D. Connelly Boiler Company
Superheaters, 4, 1,820 sq.ft., 150 to 230 deg. F.	Superheater Company
Air-cooled walls and arches	M. H. Detrick Company
Blowoff valves	Edwards Valve & Mfg. Co.
Feed-water regulators, Copes	Northern Equipment Co.
Soot blowers, 7 per boiler	Vulcan Soot Cleaner Company
Safety valves	Crosby Steam Gage & Valve Co.
Combustion control, Craig	A. W. Cash Co.
Stokers, 4, Green chain grate, 209 sq.ft.	Combustion Engineering Corp.
Forced-draft fans, 3, 30,000 c.f.m.	American Blower Corp.
Fan drive, 2, motor driven	Allis-Chalmers Mfg. Co.
Fan drive, 1, turbine driven	De Laval Steam Turbine Co.
Breeching and air ducts	Connery & Co.

Fuel-Handling Equipment

Steel track hopper, 8 tons capacity	Beaumont Mfg. Co.
Automatic skip hoist, 1 ton capacity	Beaumont Mfg. Co.
Automatic fuel lorry, 1 ton capacity	Beaumont Mfg. Co.
Ash hoppers	Allen-Sherman-Hoff Company

Water Treatment

Cold lime-soda process, 24,000 gal. per hr.	Wm. B. Scaife & Sons Co.
Evaporators, 3, 4,000 lb. per hr.	Foster Wheeler Corp.
Water heater, 1, open deaërating type, 175,000 lb. per hr., 228 deg. F.	Hoppes Manufacturing Co.
Low-pressure stage heaters, 3, 185 sq.ft.	Whitlock Coil Pipe Co.

Main Steam Units

Turbines, 3, 7,500 hp., condensing, two-stage bleeding	Ingersoll-Rand Co.
Blowers, 3, 70,000 c.f.m., 25 lb. pressure	Ingersoll-Rand Co.
Turbines, 3, 450 hp. condensing	Terry Steam Turbine Co.
Gas boosters, 3, 42,000 c.f.m., 2 lb. pressure	Ingersoll-Rand Co.
Turbine generator, 1,000 kw., non-condensing, standby	Westinghouse Elec. & Mfg. Co.

Pumping Equipment

Service pumps, 4, 4,200 g.p.m., 1,750 r.p.m., 150-ft. head	Worthington Pump & Machinery Corp.
Pump drives, 3, 300-hp., 2,300-volt motors	Allis-Chalmers Mfg. Co.
Pump drive, 1, 300-hp. turbine and gear	Westinghouse Elec. & Mfg. Co.
Service pump, 1, 3,000 g.p.m., 150-ft. head, driven by direct-connected turbine	De Laval Steam Turbine Co.

Condensing Equipment and Auxiliaries

Surface condensers, 3, two-pass, divided water box, 5,700 sq.ft.	Allis-Chalmers Mfg. Co.
Surface condenser, 1, three-pass, 2,800 sq.ft.	Allis-Chalmers Mfg. Co.
Air pumps, 6, two-stage steam-jet air pumps and condensers	Allis-Chalmers Mfg. Co.
Condensate pumps, 3, 125 g.p.m., each driven by a.-c. motor	Allis-Chalmers Mfg. Co.
Cir. pumps, 3, 514 r.p.m., 8,000 g.p.m., 25-ft. head	Fairbanks, Morse & Co.
Cir. pump drive, 2, 75-hp. 440-volt, 514 r.p.m. motors	Fairbanks, Morse & Co.
Cir. pump drive, 1 75-hp. turbine and gear	De Laval Steam Turbine Co.
Boiler feed pumps, 3, 5-stage, 200 g.p.m., 3,000 r.p.m., direct-connected to steam turbines	De Laval Steam Turbine Co.

Piping and Valves

Piping	B. Floersheim & Co., Inc.
Gate valves	Walworth Co.
Boiler-stop valves	Walworth Co.

Instruments and Miscellaneous

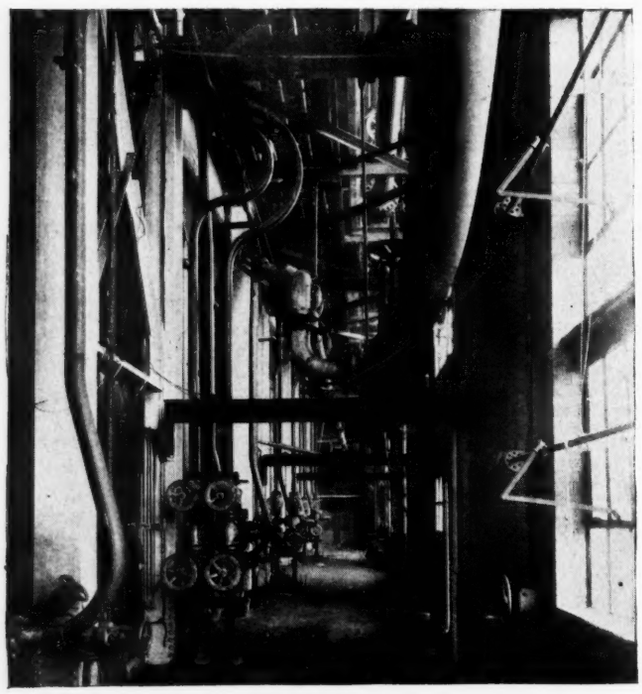
Steam boiler load indicators	Brown Instrument Co.
Steam flow meters	Brown Instrument Co.
Temperature recorders	Bristol Co.
Pressure recorders	Bristol Co.
Draft gages	Bailey Meter Co.
Feed-water meter, Venturi	Builders Iron Foundry

nation with coke breeze was a problem. The solution called for unusually high settings, special arch design, forced-draft chain grates and air preheated in hollow furnace walls to aid combustion.

Four straight-tube boilers of the cross-drum type, each containing 6,400 sq.ft. of heating surface, were installed. Although the design permits 450-lb. pressure, operation will be at 400 lb. and 200 deg. of superheat when the new turbine blowers, now on order, are installed. For the present, saturated steam at 150 lb. is being supplied to the old reciprocating blowers and pumps that are still in service.

At the time of writing, one boiler had been equipped for burning gas, another was to be fitted shortly in the same way, and the other two as soon as the surplus furnace gas available made it desirable. The introduction of a second front arch is simple, as all settings have been made the same height, with this end in view. For the combination fuel the furnace volume is 3,326 cu.ft., and the heat release at 250 per cent rating is 24,384 B.t.u. per cu.ft. Minus the arch for gas burning the furnace volume is 3,736 cu.ft., and the heat release at the same rating 21,708 B.t.u. A forced-draft chain grate having 209 sq.ft. of effective area serves each boiler.

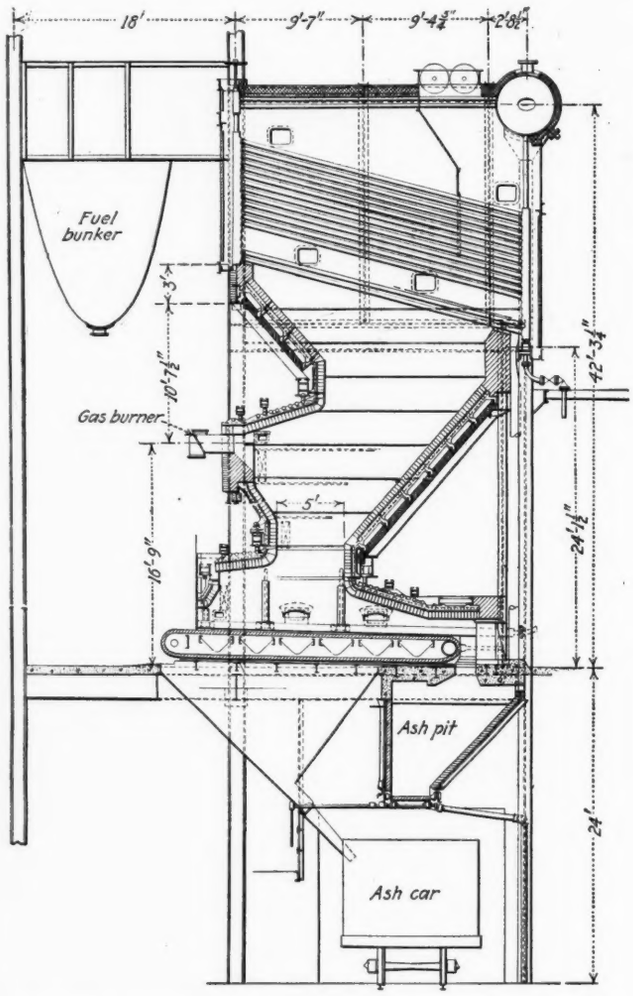
Arches open to the air have been provided front and rear. In the combination setting, two combustion arches have been injected at the front of the setting, one to serve the stoker, and ten feet higher up, a secondary arch to maintain proper combustion temperature for the furnace gas. A long rear arch reduces the throat for the upward passage of the stoker gases to 60 in. This arch



Roomy aisle back of boilers showing feed-water piping and main steam header

is set low and with the proper incline to throw back on the grate for burning any light particles of breeze that have been raised by the stronger air pressure carried in the rear zones of the stoker. From the curtain wall at the heel of the arch, the rear wall of the furnace slopes backward to expose practically the full length of the tubes to the radiant heat of the fire.

The boiler settings are provided with sectional air-cooled walls, divided into horizontal lanes about 30 in. high, passing from front to rear. Through dampered openings at the center of the front wall air is admitted to each lane, the amount varying according to temperature requirements. This cooling air divides at the admission ports, equal amounts passing each way through the respective lanes in the side walls to collecting ducts at



Sectional elevation of boiler, showing the high setting permitting two combustion arches, one for each fuel, and a long rear arch

the rear of the setting leading to the forced-draft fans. Temperatures of the air leaving the walls approximate 150 deg. F.

Air preheated in the furnace walls is delivered by three forced-draft fans to a common duct running the length of the boiler room. Two of these fans are motor driven and the third is directly connected to a turbine. This common supply is delivered through a dampered outlet to each stoker, and from the same source air for burning the furnace gas is supplied. The gases of combustion pass to a concrete stack 225 ft. high and 12 ft. in diameter at the top.

To permit operation at variable speed the stokers are driven by direct-current motors, receiving their supply of energy from the substation, with a storage battery to draw on as a reserve source of power. The motor speed is regulated by an automatic combustion control system functioning from the steam pressure, which also regulates

the position of the dampers in the forced-draft ducts. The fans operate at constant speed to maintain a constant pressure in the main air duct, and the volume of air to the stokers is determined by the position of the dampers. The main boiler uptake dampers are controlled by the furnace pressure.

Gas from the blast furnaces, drawn off at a point in the main preceding the wet scrubbers, is delivered to the boiler house at about fifteen inches of water pressure. By a butterfly regulating valve in the line, this pressure is reduced to 3½ in. for delivery to the mixing chamber of the burner. Preheated air from the main air duct is supplied at the same pressure in a ratio by volume of 0.77 to 1 of gas. Normally a four-inch bed of coke breeze is carried on the grates, but the amount of breeze burned is varied according to the supply of gas available. Operation up to 250 per cent of rating has proved to be quite feasible, and approximate tests have shown that efficiencies with the combination fuel range from 70 to 72 per cent.

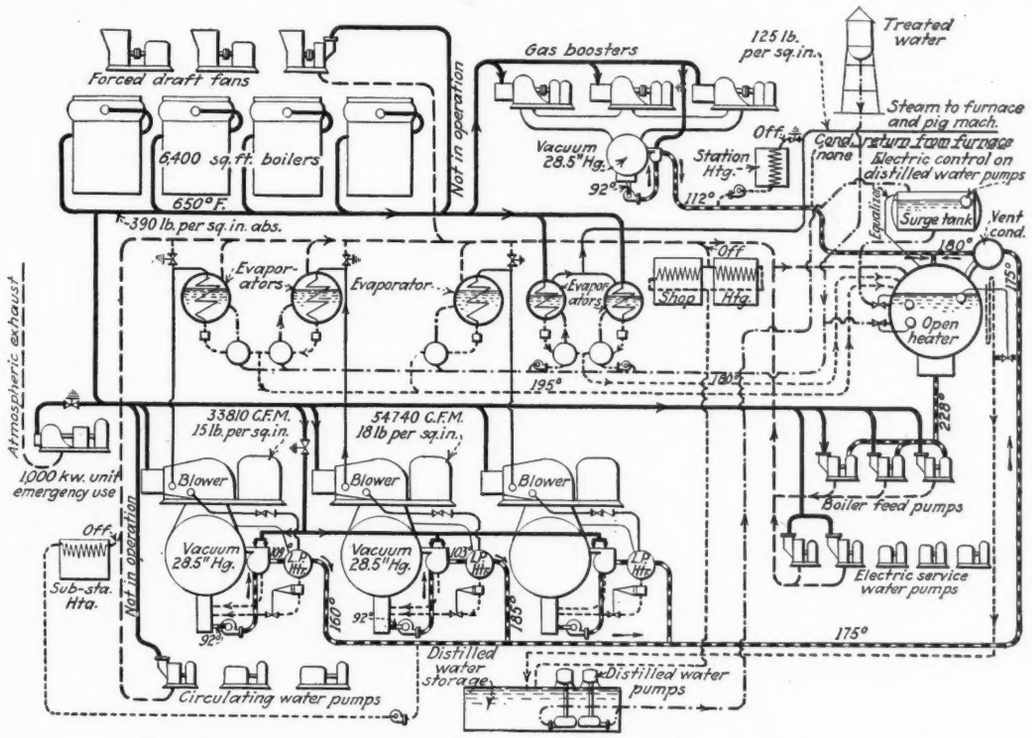
Delivery of coke breeze is made by railway cars that dump into a track hopper delivering into a skip-hoist that functions automatically in connection with a lorry passing over the bunker in the boiler house.

Water for the plant comes from the Calumet River. The raw water shows 6.6 alkalinity and 6.4 hardness. In a cold-process system using soda ash and lime the hardness is reduced to 0.8 grains per gallon and is filtered to a clear well supply. This feed water is passed through an open heater to be delivered to the boilers at 200 deg. F. under the control of feed-water regulators. At present the old reciprocating feed pumps handle the supply.

This arrangement is temporary, as it will be recalled that the boilers are to operate at 400 lb. pressure to supply the new turbine blowers, when they are installed in the course of a few months. The steam and feed-water cycles will then be arranged as indicated in the heat-flow diagram and convection superheaters will be installed in the boilers.

There will be three turbine blowers, each equipped with a surface condenser. The turbines driving the three gas boosters already installed deliver to a single surface condenser, so that the condensate and all other returns will be brought back to the open heater, as indicated in the diagram. With this arrangement the make-up probably will not exceed 3 per cent, as compared to 100 per cent in the old plant, equipped with reciprocating blowers served by barometric condensers.

This diagram also shows the new auxiliaries, consisting of three 200 g.p.m. turbine-driven centrifugal boiler feed pumps, taking steam at boiler pressure; two turbine-driven and three motor-driven service pumps, one turbine-driven and two motor-driven circulating pumps; the same type of drive for the forced-draft fans; and a 1,000-kw. emergency generating unit that will serve as a standby to the purchased service. This service comes in at 12,000 volts and is transformed to 2,300 and 440 volts for plant use. Make-up from the treated water supply will be passed to three evaporators. Primary steam for each of these evaporators will be bled from one of the blower turbines at 50 lb. pressure. The vapor from the evaporators will be delivered at five pounds pressure to a common line receiving, in addition, the exhaust from the auxiliary turbines to heat the feed water in the open heater to 228 deg. F. Connection to this same exhaust line will be made for shop heating. Other bleeder connections to the blower turbines supply steam at atmospheric pressure to heat condensate in closed heaters before it goes to the open heater.



Flow diagram for furnace plant, showing extensive use of evaporators

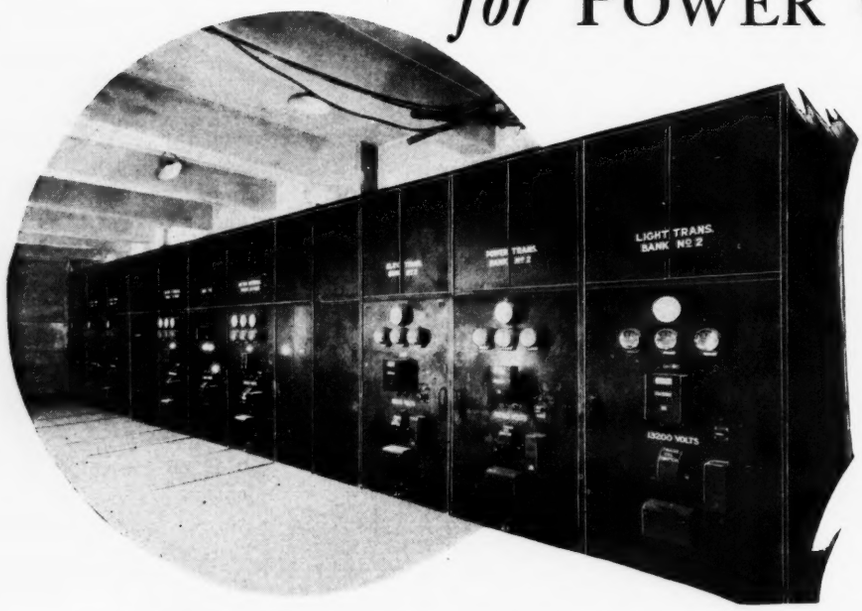
To maintain a high-pressure closed system and still supply steam at 125 lb. pressure to the furnaces and the pig machines, two single-stage evaporators, each having a capacity of 10,000 lb. per hr., will be provided. These evaporators will take steam at boiler pressure and, using treated water, will deliver steam at 125 lb.

M. A. Tack, chief engineer of the By-Products Coke Corporation, in co-operation with Sargent & Lundy, consulting engineers, is responsible for the new adjustment of fuels and the new layout of the equipment.

STATION PERFORMANCE ABROAD—According to a report of the British Electricity Commissioners, the Padihan and the Barton stations lead in economy among stations in England. The former, with a fuel consumption of 1.37 lb. of coal per kilowatt-hour, shows a thermal efficiency of 21.03 per cent at 36.2 per cent load factor, while the latter at 1.39 lb. of coal has an efficiency of 21.07 per cent and 51.2 per cent load factor.

Truck-Type Switchboards *for* POWER CONTROL in Public Buildings

By G. H. KOHN
Switchgear Engineering Department, General Electric Company



In Philadelphia's largest office building truck-type panels control the power supply

LIGHTING and power loads in public buildings are of primary importance and should be carefully considered. The switching equipment should be reliable, safe, easily installed, operated and maintained with a minimum amount of apparatus. Banks, theaters, office buildings and department stores have solved their problem by the installation of truck-type panels. Large operating companies have also realized the advantages of enclosed, removable switchgear to the extent of stocking truck-type panels for incoming-line service for their customers' installations.

Interruptions to service are minimized by introducing a spare truck or spare feeder unit when it becomes necessary to withdraw a truck for inspection or adjustment. All trucks of the same type and circuit rating are made interchangeable with the corresponding stationary members. Inspection and repairs are made in safety away from high-voltage parts at the convenience of the attendant.

The time and cost of installation are reduced to a minimum, as all units are assembled and wired before shipment. When it becomes necessary to make alterations or extensions to the building, with resulting changes to the switching equipment, these can readily be accomplished by the use of factory-built, self-contained truck-type panels.

Complete protection is afforded while the equipment is in service, as all live parts are totally enclosed. Automatic shutters cover the remaining live parts in the housing when a truck is removed. The fire hazard is also reduced, as its effects are confined to the immediate location of the fault.

On truck panels the disconnecting devices act as isolating switches, and interlocks prevent the insertion and withdrawal of the truck from the housing with the oil circuit breaker closed. The oil circuit breaker is also rendered inoperative unless the truck is totally disconnected or in the normal connected operating position. Also the truck may be padlocked in the disconnected position, thereby permitting remote repairs to be made in safety.

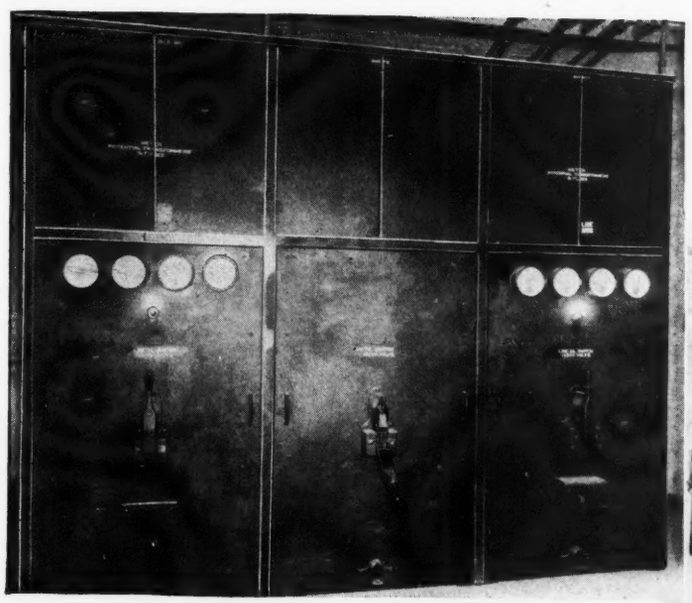
Apparatus and devices necessitating periodic inspection, such as the oil circuit breaker with its accessories, are mounted on the removable element, and, for moderate duty service, the instruments and instrument transformers, relays and control devices.

Isolating the breaker through disconnecting devices rather than by means of overhead disconnecting switches reduces the height of the switchboard room to a minimum. Also, the removable element can be taken to a location where sufficient height is available for the lowering of oil tanks by raising the truck over the tank. This may also be accomplished by means of a pit.

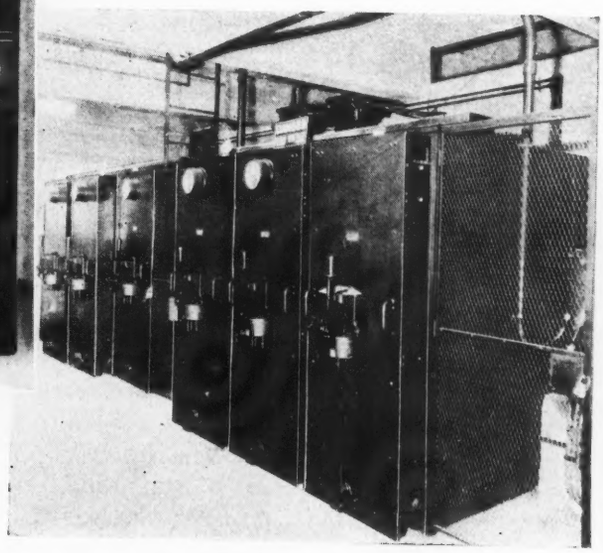
A ground bus extends the full length of the switchboard, and a disconnecting ground contact interconnects the truck and housing members.

The initial cost of a truck-type installation might appear to be excessive. For equal safety, equal functions, and equal convenience of operation, maintenance and installation, the overall cost of this class of equipment is less than that of other types. A comparison should be made only with an installation of cells or other types of enclosures, with interlocked isolating switches and some method of bypassing the oil circuit breaker. The result is a complicated switching scheme, with an inaccessible oil circuit breaker. These requirements are often essential to meet safety and fire regulations in various localities.

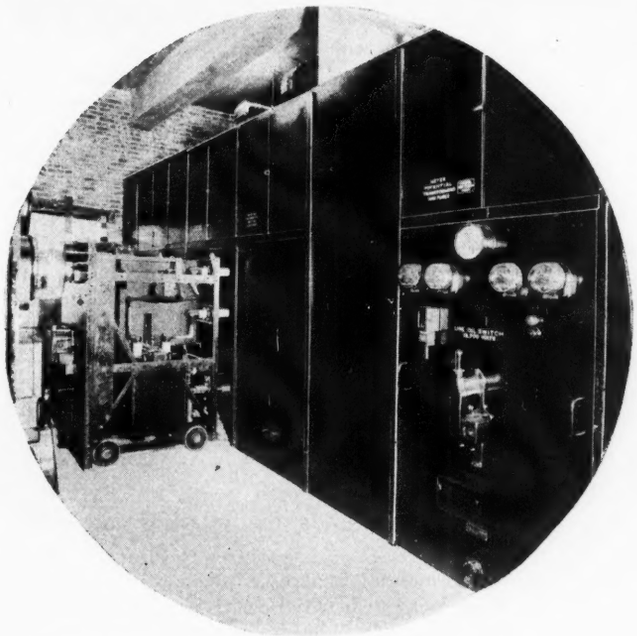
TYPICAL INSTALLATIONS



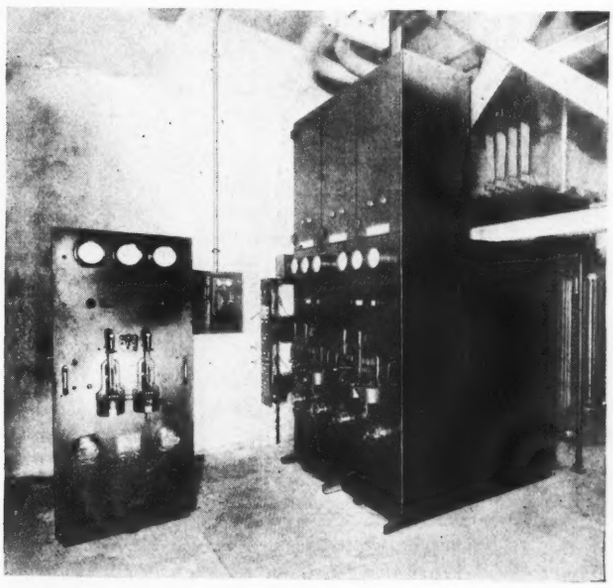
Theater installation of 13,200-volt truck-type switchboard



Truck-type panels in the Bush Terminal Building, New York City



Truck-type panels for 13,200-volt power in a department store



(Above) Truck-type switchboard with double busbars as installed in bank and office building for controlling 2,300-volt power

(Left) Truck-type panels with double busbars as installed on a 2,300-volt power system in a large department store

Power Supply Study of a Typical Office Building

OUTSIDE OF OVERHEAD CHARGES, *the biggest expense of an office building is power. If profits are to be realized the management must obtain energy for lights, motors and elevators in the cheapest way. Sometimes a building power plant is the best solution, and in other cases purchased energy works out better. In this article, J. G. Berger shows how to examine the proposition, using an actual building as the subject.*

BY J. G. BERGER
Consulting Engineer, Newark, N. J.

ONE of the problems of an office building manager is that of cheap power and how to obtain it. When available office space in a good building was not so easily obtainable as today and rentals based on the purchasing value of the dollar were higher, cost of running an office building was viewed with some indifference. Today, however, we find office space being sold in a competitive market, hence the operating cost of the department that supplies heat, light and power is more carefully watched than heretofore. Building owners now purchasing power are studying the advantages of generating power in the buildings, while those now generating power are examining the inducements offered by the public utility.

To one not trained in engineering it is difficult to give proper credit to the various plans offered, and many have turned for advice to competent unbiased consulting engineers, who readily see down to the bare facts and calculate the relative operating costs and the range they may take in common practice.

To show how such a comparison may be made, the Federal Trust Building of Newark has been taken as a basis, as it is typical of the average metropolitan structure used for business offices. This building is four years old, the power is purchased and costs have been set up on the assumption that a steam-engine plant or a Diesel-engine plant was to be installed to supply power.

The building is typical in many respects. It is 20 stories high, in part, and with two basements, the total space is 2,726,000 cu.ft. The floor area is 222,000 sq.ft., of which 119,000 sq.ft. is rentable for offices and about 27,000 sq.ft. is rented in the basement. Of the eight elevators three operate to Floor 7 and the balance to Floor 18. The type of tenants is not different from those found in the average office building, and practically all offices close at about 5 P.M. This information is given in order to enable the reader to make proper allowances for conditions known to him, but he should bear in mind that the results of this study are not a yardstick to be applied to other buildings even if the conditions appear to be very similar.

Needless to say, the comparison of power costs was carried on in the most impartial manner. Figures were based on actual conditions which the author has met in his years of experience in this work. Since investment as well as operating costs vary considerably with the type of equipment selected, the manner in which the installation is made, policy of management and other conditions, it was thought desirable to give in each comparison a high and a low figure.

To compare with the present method and costs, this study considers the steam power generating plant as Method 2 and a Diesel plant as Method 3. There are, of course, other possibilities. For instance, high-pressure steam can be used for the generation of power during the cold season and the exhaust for heating purposes. To simplify the comparison, such items and equipment that would appear in all of the methods have been omitted.

The records show that on an average 564,000 kw.-hr. a year are purchased, of which 346,000 are for light. Only two tenants, who are large consumers of current, are submetered, but no profit is made, inasmuch as the rate at which they are charged is the same as paid by the building. The average power demand during the day is 120 kw., with peaks of 210 kw. and a maximum demand of 225. The demand for light does not fluctuate as much, averaging 125 kw. during the day, with peaks around 160 kw., the maximum being 180 kw. The combined average demand is 240 kw., while the combined demand on which the capacity of the equipment is to be based is about 350 kw., with a peak of somewhat more than 400 kw. The 350-kw. load occurs during the rush hours and lasts longer than desirable for the generator to carry as an overload. Based on these figures the yearly load factor of this building is about 18 per cent. The night load is small. The combined load of the vacuum system, one elevator and the lights does not exceed a demand of 60 kw. except for occasional peaks. The current is supplied at high tension but is purchased on the low-tension side.

This building is protected against power breakdown with a type of service that in an emergency will enable

the power load to be thrown on to the lighting feeders, and vice versa, each feeder and set of transformers being large enough to take the whole load. This arrangement has proved itself useful and has avoided shutdowns to date. While it is true that an injury to the incoming line would shut down the building services, still it must be conceded that this is an exceptional condition. Providing breakdown services means providing against such failures as can be reasonably expected and on an average the possibility of failure of an engine is no doubt greater than that of an underground cable.

Steam for heating is supplied by three Kewanee heating boilers capable of handling 25,000 sq.ft. of radiation, of which two are in operation. The cost of the boilers was $12,000. The maximum evaporation of these boilers is about 8,000 lb. of steam per hour, and about 640 tons of No. 1 buckwheat coal are burned during the cold season. Two firemen are all that are required to operate the plant for eight months of the year. All the other equipment outside the boiler room is automatic and requires only occasional lubrication and inspection. The maintenance and repair costs for the boiler room averaged $100 a year during the last three years.

Coal is contracted at $6.75 per ton, and a six months' supply can be stored in a 350-ton bin. Hot water is made with a submerged-type heater, but during the five summer months a separate hot-water boiler is in use; about 18 tons of a larger size of coal is charged to this item.

As far as value of the floor space for the engine room is concerned, the figures charged to the power plant, $0.75 to $1.25 per sq.ft., are those actually paid by tenants. In fact, part of the basement space in the Federal Trust Building is rented at a much higher figure, namely $1.85 per sq.ft., but this being an exceptional case, it was not taken into consideration.

To provide for a demand of 350 kw. during the day and about 60 kw. during the night it seems advisable to consider two 175-kw. uniflow units, one 100-kw. 4-valve counterflow unit and one 75-kw. 4-valve counterflow unit.

This arrangement would be flexible and at the same time economical. The 100-kw. and 75-kw. units would serve as spares in case one of the 175-kw. units should break down. The higher steam consumption of the counterflow engines would not matter, since they would be used only in emergency and for standby equipment. On the other hand, in very cold weather, when much heating steam would be required, the exhaust from a uniflow might not suffice, in which case the counterflow would run at night only and the exhaust would take care of the increased hot water needs for the cleaning period.

The cost of this equipment is listed as shown:

2 175-kw. uniflows at $65 to $75 per kw. installed	$22,900 to $24,500
1 100-kw. counterflow at $45 to $50 per kw. installed	4,500 to 5,000
1 75-kw. counterflow at $45 to $55 per kw. installed	3,275 to 4,125
Total	$30,675 $33,625

Three 2,000 sq.ft. water-tube boilers would have to be provided instead of the three 1,500 sq.ft. heating boilers in the building. These boilers installed, with breeching complete would cost from $3.50 to $4.50 per sq.ft., totaling $21,000 to $27,000.

The total additional cost for a steam power plant then would be:

Engine-generator units	$30,675 to $33,625
Auxiliaries	1,000 to 1,500
Piping and wiring, including exhaust piping	4,000 to 5,000
Boilers	21,000 to 27,000
Total	$56,675 to $67,125

This price range might be contested, because a simpler engine plant could be installed, but it is doubtful if this would result in savings, since the increase in operating costs due to higher steam consumption would probably more than offset the reduction in fixed charges.

Turning to the Diesel plant: To provide flexibility and economy in operation, it was decided that consideration should be given to two 175-kw., one 100-kw. and one 50-kw. Diesel unit. Leaving out the cost of the switchboard, which would be the same in either method, this Diesel plant installed completely would cost:

Two 175-kw. Diesel units at $150 to $165	$52,500 to $57,800
One 100-kw. unit at $165 to $180	16,500 to 18,000
One 50-kw. unit at $185 to $200	9,250 to 10,000
Total	$78,250 to $85,800

Using the engine exhaust for the generation of steam or producing hot water would be possible, but it would have little economical advantage, due to high investment cost of waste-heat boilers. Such an installation would have little effect on the boiler-capacity requirements. In this particular case, with the average load in the neighborhood of 200 kw., about 175 pounds of steam per hour could be obtained, which is negligible when compared with an average of 6,000 lb. required to heat this building. Therefore the same boiler plant was considered in connection with the Diesel installation plant as with purchased power.

A fourth method might have been considered, one of purchasing current at night only and generating during the day, and many other variations from the three base methods given. In a detailed investigation this would normally be done with a view of determining the lowest operating cost and the least investment.

TABULATION OF COMPARATIVE OPERATING COSTS

Method 1 (purchased current)			Method 2		Method 3	
Coal, $6.75 per ton	840 tons	$4,320	1,600 to 1,800 tons	$10,800 to $12,100	640 tons	$4,320 to $4,320
Fuel oil at 5 cents (for hot water)		250			42,000 to 53,000 gal.	2,100 to 3,200
Lubrication			0.5 to 0.75 mills per kw.-hr	280 to 425		280 to 420
Maintenance and repairs		100	1.5 to 2.5 mills per kw.-hr.	850 to 1,400	2 to 3 mills per kw.-hr.	1,100 to 1,700
Labor	1 engineer, and 2 firemen for 8 months	4,830	1 relief man and 1 oiler, 1 engineer, 1 assistant, 2 firemen	11,500 to 13,500	1 engineer, 1 assistant, 2 firemen, 1 relief man for 8 months and 1 oiler	10,500 to 12,500
Water		50	Water	400 to 500	Water	600 to 800
Purchased current. for light		14,460				
Purchased current. for power		6,250				
Value of engine room space, per year			1,500 to 2,000 sq.ft. at $0.75 to $1.25	1,120 to 2,500	1,500 to 2,000 sq.ft. at $0.75 to $1.25	1,120 to 2,500
Fixed charges	13 per cent on $12,000 (value of low pressure boiler)	1,560	13 to 15 per cent on $56,675 to $67,125	7,360 to 10,500	13 per cent on low-pressure boilers	1,560 to 1,560
					14 to 16 per cent on $78,250 to $85,000 Diesel plant	11,000 to 13,600
Total		$31,820		$32,310 to $40,925		$32,580 to $40,600

The question of a gasoline engine for standby and breakdown service was considered. It is a question, however, whether it would alter the set-up to any extent. The cost of such a unit of 100-kw. capacity completely installed is over $10,000 and besides there is the problem of storing the gasoline for which there are special regulations that must be complied with. On a whole this investment will probably offset the saving of a cheap steam engine and a third boiler, or at best the difference would be very small when fixed charges are figured.

For the purpose of this study, however, it was best to confine the comparisons to three fundamental ways of producing the heat, light and power.

The table shows the rather unusual condition that, taking the low range of costs, there would be little difference between the three methods. Let us, however, proceed to analyze further the facts before us.

The advantages of purchasing the current are that from $44,675 to $85,800 would be saved in investment, which money may be used in other items of construction on which a greater return than 6 per cent interest can be earned. In addition, there would be freedom from certain maintenance items.

The advantages of making the power either with steam or Diesel engines would improve as soon as the load factor increased through the tenants' consuming more electric current and steam for a greater number of hours during the day. It happens at 18 per cent load factor the operating costs are close together, whereas at 25 or 30 per cent load factor the operating costs would be more favorable for the steam or oil-engine plant.

What is true in Newark, N. J., would not be true in a territory where coal prices, central station rates or oil prices varied from those used here. Besides, climatic conditions are a big factor, as the longer and colder the heating season the more the steam plant is favored, whereas shorter and less frigid heating seasons the central station and Diesel plant are favored.

It is indeed a problem of relative advantages and disadvantages, which requires competent engineering knowledge for the correct answer.

In this study, the coal used by the steam plant was based on average of 35 lb. of steam per kw.-hr. with non-condensing unaflows and 50 lb. for the non-condensing counterflow, the back pressure being from 1 to 1.5 lb. gage. A boiler efficiency of 67 per cent was assumed. The fuel for the Diesels was based on a fuel consumption of from 0.6 to 0.75 lb. of oil per kw.-hr. The cooling water charge was based on 16 gal. per kw.-hr., after deduction of 120,000 cu.ft. used for house water.

In concluding, it would be of interest to note a local situation as regards an office building in Binghamton, N. Y., the Kilmer Press Building. This building serves a newspaper and stores day and evening and sells electric current and steam to its neighbors. The load factor there obtained on a 24-hour, 7-day week basis is around 35 per cent, the building has about the equivalent square feet of the Federal Trust Building and makes all of its electric current in a uniflow-engine plant. The profit derived from this operation is several thousand dollars per year. If they sold no current or steam and had tenants whose consumption of electric current was more nearly normal it would no doubt pay them to buy their current.

This again emphasizes that much overworked statement that each office building must stand on its own facts, which is the reason for the consulting engineer.

Tests of Worthington Double-Acting Diesels

THE two Worthington 3,625-hp. Diesels for the vessels "Potter" and "Jeff Davis" were recently tested under supervision of the Shipping Board's engineers.

Shipping Board specifications required all of the tests to be made with a fuel oil equal to standard navy fuel, grade 2B. No centrifuging or similar treatment of the fuel was allowed. Some difficulty was experienced in finding an oil to meet these specifications, as the fuel oils generally obtainable in this country for Diesel engines are of a much better quality. The only treatment permitted was heating to approximately 90 deg. F. to make the oil sufficiently fluid to flow to the fuel pump. The engines operated without the least difficulty, and the exhaust was practically invisible at all times.

Summary of the shop tests:
Worthington double-acting two-stroke cycle engine

Engines:	A	B
Cylinders, bore by stroke, in.	28x40	28x40
Number of cylinders	4	4
Duration of test, hours	168	24
Revolutions per minute	114.96	115.0
Brake horsepower	3,723	3,749
Indicated horsepower	4,672	4,840
Mean indicated pressure	85.9	89.0
Mechanical efficiency, per cent	97.7	77.5
Scavenge-blower motor input, hp	171	182
Fuel, lb. per I. hp.-hr.	0.327	0.322
Fuel, lb. per b.hp.-hr.	0.411	0.416
Fuel, lb. per b. hp.-hr., including blower	0.43	0.437
(Corrected for net heat value)	0.402	0.409
Lubricating oil, gal. per 24 hours—		
Power cylinders	8.73	7.75
Piston rod stuffing boxes	3.08	3.1
Air compressor	0.48	1.25
Temperatures:		
Cooling water to engine, deg. F.	59	63
Cooling water from engine, deg. F.	113	112
Exhaust pressures:	453	422
Injection air, lb. per sq.in.	934	946
Scavenge air, lb. per sq.in.	1.77	1.86
Cooling water, lb. per sq in.	38	34
Fuel characteristics:		
Gravity, Baumé at 60 deg. F.	19.5	20
Viscosity, Saybolt furol at 77 deg. F.	77	66
Congealing point, deg. F.	16	13
Water, per cent	0.84	0.83
Sulphur, per cent	0.75	0.76
Distillation above 700 deg. F., per cent	81	92.0
Carbon residue, per cent	5.01	5.98
Heat value, high, B.t.u. per lb.	18,848	18,906
Heat value, net, B.t.u. per lb.	17,717	17,772

These engines have the hollow piston rods chrome plated, both inside and outside. This reduces corrosion danger and, of more importance, permits the use of a ductile mild steel, for the plating is hard enough to eliminate wear at the stuffing box.

Efficiency of Turbines Lowered But Little by Blade Erosion

LOWERING of efficiency of steam turbines due to erosion on the blades has been found to be practically negligible in a test carried on by the engineering experiment station of the United States Navy Department. The test was conducted on a 72-boiler horse power Sturtevant re-entrant wheel type turbine.

Actual wear, such as was found on a turbine in use for twelve years was simulated by cuts on the face of the blades on that portion struck by the incoming steam. The first cut, which indented the edge one-sixteenth of an inch from the original, corresponded to more than ten years' average operation. Steam consumption was then determined at various loads for several constant-speed conditions, but no appreciable rise was noted.

Successive one-eighth inch cuts were then made, and finally a five-sixteenth indentation clear across the blade. The tests showed that at normal speed only excessive cuts, corresponding to more than normal wear, produced more than a 2 per cent change in steam consumption.

Where Are We Headed In ENGINEERING EDUCATION?

By P. W. Swain
Associate Editor of Power

AMERICA, more than all other countries, is marked by the engineer. Twenty million automobiles rolling day and night over a network of highways, great transportation systems by rail and bus, cheap power, mass production, high wages, short hours, radio, innumerable conveniences and luxuries undreamed of 50 years ago—all these are his imprint on our civilization. They bear witness to the amazing social power released by the incessant impact of trained minds on facts.

The engineer's passion for facts is an obsession he shares with the scientific investigator only, but the engineer is unique in his ability to apply facts to immediate practical objectives. Our system of engineering education has been the dominant factor in producing men of this type, and their accomplishments are an unanswerable justification of the general conduct of that system.

Technical knowledge, character and ability to base decisions on the logical interpretation of facts have made the engineer a dominant factor in American industry in spite of too frequent deficiencies in business sense, general culture and knowledge of human nature. Courageous facing of the problems of technical education promises better rounded engineering leaders without sacrifice of the pioneer virtues.

This does not mean, however, that everything is rosy with engineering education, or that its methods and product approach perfection. Engineers are selected almost daily for positions of leadership in industry because they "know their stuff" and because in any situation they first search for the underlying facts and then proceed systematically to work out a logical line of action. Just as often, on the other hand, the engineer-candidate for a key position is passed by in favor of the banker, lawyer or traditional type of business man, because the latter has a keener appreciation of sales or finance or a more happy technique of marshalling men for a common objective.

There is, of course, danger that too much emphasis may be placed on the Napoleons of industry in the evaluation of engineering education. The statistical fact that the majority of graduates eventually achieve administrative positions in industry does not, and obviously cannot, mean that more than a small percentage become presidents of corporations or otherwise win popular classification among the "great men" of industry. Nature may waste a million eggs to produce one adult fish, but education cannot be so prodigal of its raw material, and it would be criminal folly to direct engineering education solely to the production of captains of industry, just as it is a serious error to evaluate various educational methods by the number of famous graduates.

The pertinent fact to be noted by those who administer educational medicine to the future engineer is that probably three-quarters of these men will eventually be called upon to direct the work of other men—but that they will reach these positions *only* by traversing the hard road of technical effectiveness and will be asked to direct *only* because they have demonstrated a profound grasp of the work to be done.

Engineers are not generally selected as administrators *per se,* but because our industrial machine is so complex in its technical relations that none but an engineer can see how the wheels go round. Boards of directors have acquired a wholesome fear of the damage that may result if the control of this mechanism is left too much in the hands of the man who is simply a natural leader and who does not understand the technical aspects of the job. So they turn over to the engineer most of the staff positions of industry, hoping and praying that he will possess or acquire enough general managerial sense to handle the human and financial aspects of his job. When this talent appears in unexpected measure its possessor is in line for one of the so-called "key" positions.

In his brilliant virtues and notable defects the typical graduate engineer is, to a large extent, a reflected image of his teachers and a logical result of the personalities and ideas that surround him during four of the most significant years of his career. No group of teachers in America today is more honest in its desire to perform a worthy educational job. None is as willing to take its own medicine by applying to the teaching job itself, and to the teaching personnel, the objective methods that have proved so successful in dealing with machines and with industry. This is not a mere idle statement. Strange as it may seem, no group of university teachers except the engineering teachers have had the courage or vision—call it what you will—to institute and maintain, on an adequate scale, a nation-wide investigation of its own curricula and personnel in relation to the results to be achieved.

Five years ago the Society for the Promotion of Engi-

neering Education was authorized to conduct an extensive investigation of engineering education. With the active co-operation of the engineering schools and under the able leadership of W. E. Wickenden and H. P. Hammond, the investigating staff proceeded first, in true engineering style, to unearth the facts. Only after several years of fact-finding was any attempt made to formulate objectives.

The published facts and conclusions from the S.P.E.E. investigation over this five-year period would fill several volumes, and it would manifestly be impossible even to summarize them here. It will be worth while, however, to bring out a few of the most significant points:

It was found that the great majority of the students come from homes of moderate means. Only 4 per cent of the fathers are engineers and only 8 per cent have had a college education

Engineering Students Show High Intelligence

Tests made at the start of the freshman year reveal a grade of intelligence above that found in any other group of college students. In spite of this, the scholastic mortality is appaling. Less than 30 per cent are graduated with their classes; 60 per cent are not graduated. The cause, it was proved, lies generally in poor scholastic attainment rather than in financial difficulties. The scholastic attainments, in turn, were found to be closely hooked up with the quality of preparation, particularly in mathematics, and with the student's natural adaptation to engineering work.

Salary records of graduates and teachers brought out some significant facts. Starting salaries in teaching and industry are about the same, but financial advancement is slower for the teacher, so that 30 years after graduation he earns substantially less than the graduate in industry, even counting the teacher's outside earnings.

It was found that, as a general rule, engineering teachers are somewhat better fitted for their tasks than those in other university departments and that they are doing an honest and workmanlike job, sometimes lacking, however, in the element of inspiration. Finally it was discovered that the cost of engineering education is very high, averaging $250 yearly more than the amount paid by other students in tuition and fees.

What Employers Think of the "Product"

So much, briefly, for the raw materials and manufacturing methods of engineering education. What about the product? Here the investigating staff naturally turned to the "consumer"—to the employer of engineers in industry. The results of questionnaires to this group indicated a considerable degree of satisfaction with the grade of work being done by the engineering schools and the belief that they are, on the whole, organized along sound lines.

The demand of two decades past that engineers come to industry ready trained in specific applications has practically disappeared. In its place is a call for even more thorough grounding in the fundamental engineering sciences and an insistence that no amount of application knowledge can atone for poor preparation in these fundamentals. There is now substantial agreement between educators and leaders of industry that applications are best learned in the field. In the schools their chief use is in showing the student *how* to apply fundamentals to the solution of practical problems and to give him certain drill without which the principles themselves are not readily understood.

It was brought out in the questionnaire replies, as already pointed out, that two-thirds of the graduates ultimately find their way into administrative positions of one sort or another. At that point in their careers certain limitations of engineering education become apparent. Many of the new administrators seem to have an insufficient appreciation of the problems of finance and business. There is too great a tendency to disregard human limitations in the attempt to follow through the strict technical logic of a situation. The inbred humaneness and fairness of the engineer are too often made ineffective in dealing with complex human problems by his inability to understand and control the devious workings of human nature. Granting that business judgment and the handling of men cannot be taught as such in school, many industrial executives stress the need of the graduate for a better grounding in economics and in certain cultural courses that would humanize his education.

The significant thing about all this study and self-questioning by the engineering teacher is that the findings are not destined to moulder in the crowded archives of dead researches. Two summers ago, at Cornell and Wisconsin, the S.P.E.E. conducted its first school for engineering teachers. That session specialized on the teaching of engineering mechanics. The experiment was a success, and it was followed last summer by a school at the Massachusetts Institute of Technology for teachers of physics and by one at Pittsburgh for teachers of electrical engineering.

Summer School Conducted on Broad Lines

This summer the mechanical engineers had their innings at Purdue (June 26 to July 18), where I spent several days living with the engineering teachers, attending lectures and absorbing their point of view on their problems. Out of those contacts, and interviews with such men as Professor Hammond, director of the summer school, Dean Potter of Purdue, Professor Berry of Harvard, Professors Leutwiler and Moore of Illinois and Professor Wohlenberg of Yale have crystallized the ideas here expressed. For these views, however, I take sole responsibility, because education is not a matter on which any two men can agree in all details.

The breadth of program of the Purdue summer school and the quality of the instructional staff were something of a revelation. In the single field of power engineering, such outstanding engineering teachers as Messrs. Berry, Wohlenberg, Ellenwood of Cornell and Miller of M.I.T. were reinforced by such leaders in the field as C. F. Hirshfield, of the Detroit Edison Company, and E. G. Bailey, president of the Fuller Lehigh Company and the Bailey Meter Company. Dean Potter of Purdue as local director of the sessions showed himself a resourceful chairman. E. C. Elliott, president of Purdue University, and C. H. Judd, director of the Chicago University School of Education, contributed lectures of great value on the general principles of education.

Outside the power session such names as Hodgkinson and Leutwiler, in machine design, and Kimball, Roe and Alford, in production—indicate the high caliber of the school. Among those delivering general lectures were W. D. Ennis, consulting engineer, Ira N. Hollis, and E. P. Warner, editor of *Aviation*. Space is insufficient to record the names of others of equal prominence who took part in the instruction.

The Purdue conference was truly national in character. Seventy-five schools, from coast to coast and from

Texas to Canada, were represented in the staff and general membership.

In each of the previous summer schools some large industrial corporation has helped support the conference financially and has arranged important inspection trips. This year the Western Electric Company joined with Purdue University in support of the conference and financed all expenses of a trip to Chicago with several days of inspection trips and lectures in the works of the company.

It is not the purpose of this article to report the proceedings of the S.P.E.E. summer school, beyond indicating in a general way its significance as a part of a new trend in engineering education and drawing upon its contacts for thought along this line.

Staffed with the best available men in the whole country, the conference enabled the attending teachers, particularly the younger men, to profit by observing great teachers in action and to learn something of the new content and method that is being forced upon the engineering curriculum by recent advance in engineering practice.

Fundamentals Must Displace Frills

It became clear, for example, that some of the frills of steam power teaching, such as Zeuner diagrams and valve motions in excess doses, may well be swept aside to make room for training in fundamental attack on problems of combustion and heat transfer.

Basic formulas, such as that presented by Professor Berry for the steady flow of any substance, are coming into increasing prominence, while the specialized application formulas are being relegated to their proper minor position.

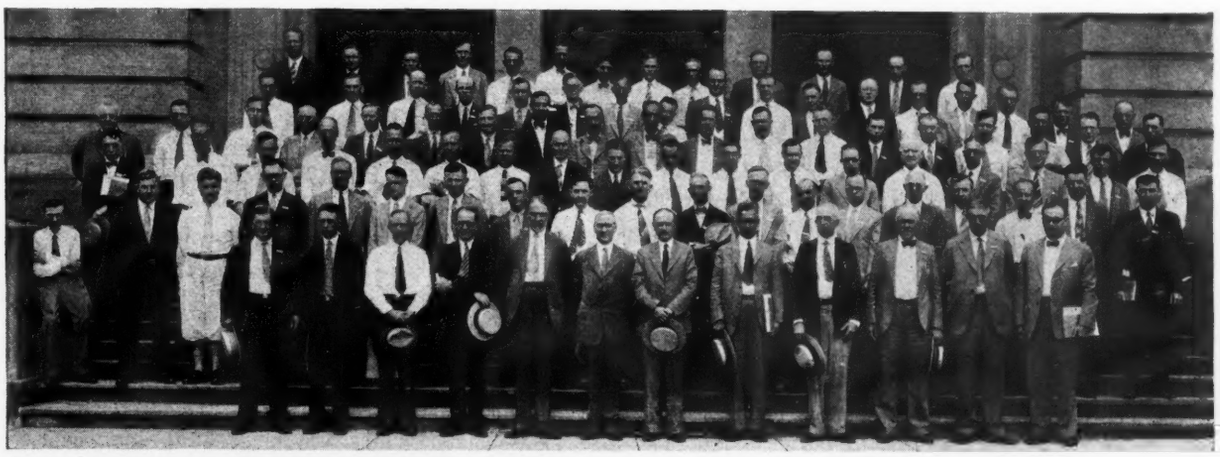
It is being more clearly recognized that no engineering problem is really solved until it is solved on a dollar basis, and problems involving the economic proportioning of equipment are winning the support they deserve.

Culture Integrated With the Engineer's Life

The cultural side is receiving a new emphasis as an integral part of engineering thought rather than as a separate, water-tight compartment of life. History and economics become industrial history and engineering economics respectively and thereby acquire a meaning never given these subjects in their classical presentation by teachers unfamiliar with the engineer's world. This significant trend is only in its infancy, because there is in the whole country a mere handful of teachers who can teach these subjects from the angle of the engineer. But the demand is there and should eventually be filled.

The great danger, emphasized in private conversations by some of those most sympathetic with the cultural movement, is that some schools may attempt to acquire breadth at the expense of depth. The engineer is where he is because he is an engineer. The old fundamentals of mathematics, physics and chemistry are still his all-important tools, which he may neglect only at his peril.

This close-up view of engineering teachers working at their problems with characteristic open-mindedness confirms the conviction that a way will be found to broaden the engineering graduate without adding hours to a schedule already sufficiently heavy and without subtracting one iota from the emphasis on fundamentals.



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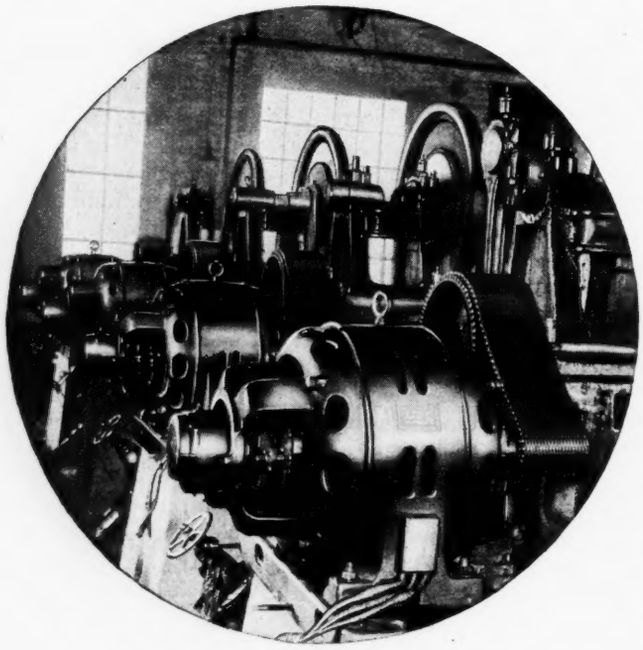
FINISHED STEEL CHAIN D



Four 60-hp. silent chains operating plunger pumps

Different forms of finished steel chain drives considered and rules given to assist industrial power engineers to select the most economical chain drive with freedom from trouble.

By CHARLES R. WEISS

Chief Engineer,

Ewart Plant, Link Belt Company.

CHAIN drives, as well as belts and gears, have their proper place in power-transmission problems, and the final selection of the type to be used must be determined by the designer or user after careful consideration.

Assume that some form of chain has been tentatively selected. Many types are available, and in making the final selection, the conditions, particularly the speed, must be considered. The most economic drive with freedom from trouble is the prime motif. In other words, the lowest-priced chain that will operate with freedom from trouble is the most economical.

In the Aug. 14, 1928, number of *Power* the selection of chain drives on cast-tooth sprockets was considered. The present article will deal with finished steel chain on cut-tooth sprockets. There are many styles of finished steel chain, but all group into three main classes, each of which will be given brief consideration.

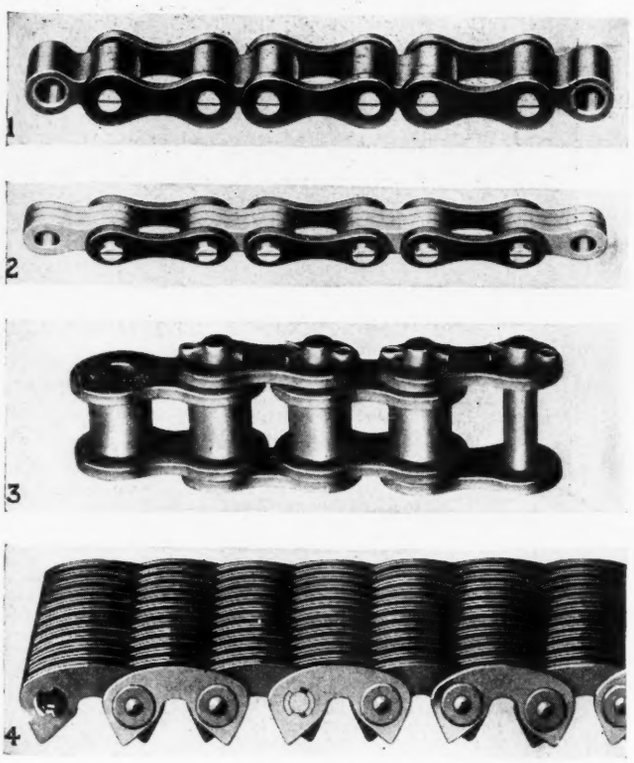
Block center, or bicycle, chain is made of steel plates with holes perforated on correct pitch for insertion of pins or rivets. The center portion of the chain is made from steel blocks, or multiples of links, provided with pitch holes, as indicated in Figs. 1 and 2 respectively. Usually, this chain is of low strength and designed for operation at low speed. To improve sprocket-wheel action, at times rollers are used instead of the block centers.

For heavier duty and slightly higher speeds, finished steel roller chain of longer pitch finds application. The center part, known as the roller link, consists of two link plates properly perforated, assembled with bushings and rollers. To complete the chain, side plates and pins or rivets are used, as in Fig. 3.

For light and heavy duty and at high speed, silent chain is preferable. As shown in Fig. 4, this chain is assembled from links of peculiar contour, designed to work directly with the flanks of the sprocket-wheel teeth. The action of the chain on the sprockets is smooth and in most cases practically noiseless, hence the name "silent chain." Several applications of roller and silent-chain drives are shown in Figs. 5 to 8.

In connection with the block center and the finished steel roller types, much has been accomplished in the way of standardization. Many of these chains will intercouple, one make with another. In the finished steel class there are certain sizes that are accepted as manufacturerers' standards. Also, in some instances one chain will not intercouple with the same number of an-

Fig. 1—Solid block center chain
Fig. 2—Multiple assembly block center chain
Fig. 3—Typical roller chain
Fig. 4—Silent chain



DRIVES

Have Wide Range of Applications

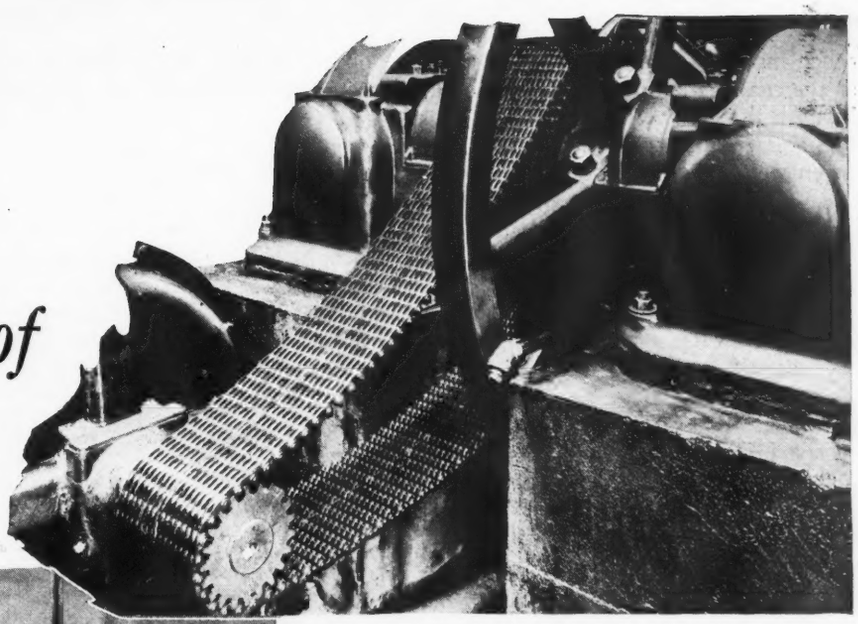


Fig. 5 (Above)—Silent chain, 8 in. wide, with middle guide, connects 60-hp. 900-r.p.m. motor to air compressor

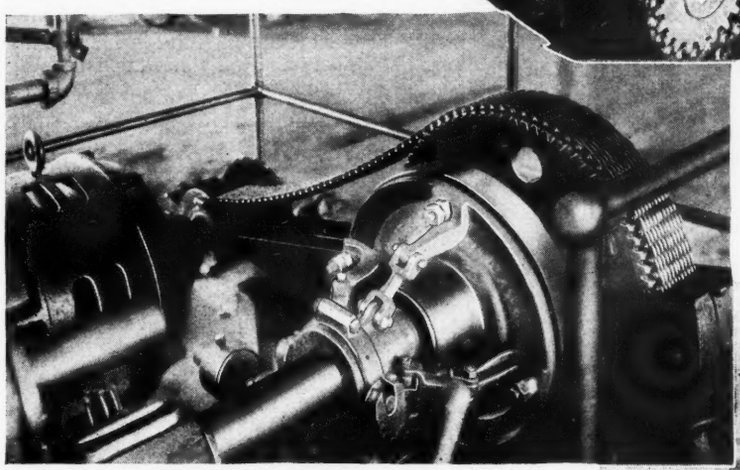
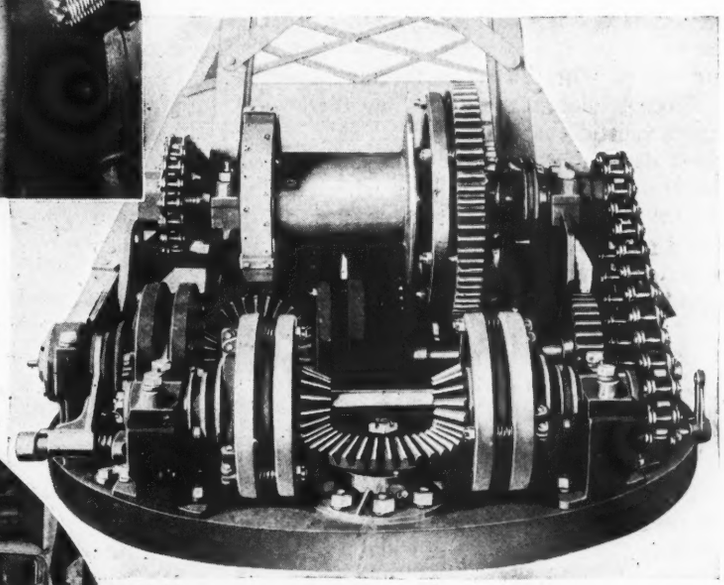


Fig. 6 (Above)—Motor rated at 25 hp. connected to its load by a silent chain ***and*** *friction clutch*



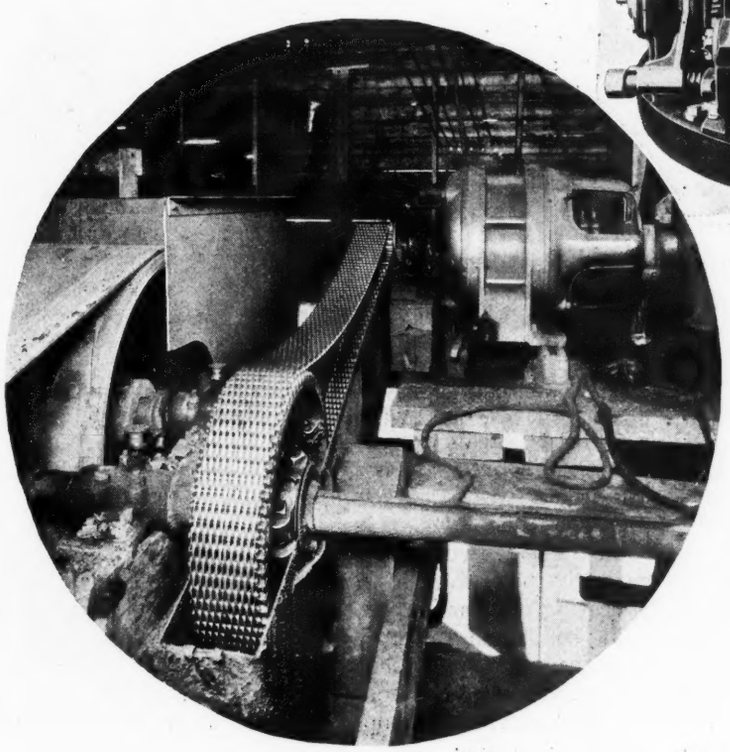


Fig. 7 (Above)—Roller chain of 1¼-in. pitch applied to power shovel mechanism

Fig. 8 (Left)—Belt conveyor for handling coal driven through silent chain by 25-hp. slip-ring induction motor. Top half of the guard has been removed to show the chain

other manufacturer, but will interchange on sprockets, as the chain pitch, the width and the diameter of the rollers are the same.

Silent chain has not been standardized, owing to the ingenious and different designs of joint construction in use. Practical experience has shown that the life of the chain depends on the joint construction. Interchangeability of silent chain on the same wheels depends on the link pitch, the included angle of the links, and the distance from the centers of the joints to the flanks of the link, where engagement is made with the flanks of the sprocket-wheel teeth.

For all the types of chain mentioned, the selection of the materials used and the heat treatment afforded have received painstaking consideration to place on a high plane the art of chain driving for power transmission. The designer has a definite problem to meet and knows the horsepower to be transmitted, the revolutions per minute, the ratio, and the center distance.

Number of Teeth in Sprocket

Where possible, in using block chain or finished steel roller chain, ten teeth on the sprocket wheel should be the minimum. An economic chain speed would be between 300 and 600 ft. per min., although at times it is necessary to use chains at a speed as low as 100 ft. per min., or even as high as 1,000 ft. per minute.

On ten-tooth sprockets at 100 ft. per min., a safety factor of six is satisfactory, and at 600 ft. per min. a factor of ten is recommended. Where the requirements are severe, more liberal factors are desirable.

Modern electric motors show their most satisfactory characteristics at high speeds. The size of the motor shaft determines the minimum diameter of the sprocket wheel or pinion that can be used. The high-speed electric motor usually dictates the use of the high-speed silent chain, although some measure of success has been obtained through the use of multiple assembly finished steel roller chain.

Silent-Chain-Drive Safety Factor

For silent-chain drives the safety factors vary, depending upon the speed and the number of teeth in the smaller sprocket. These factors vary from 29 when using 17-tooth pinions at 1,700 ft. per min. to as low as 22 over 25-tooth pinions at the same chain speed. An approximate silent-chain rating by one manufacturer gives a value of strength equal to the product of the pitch and width in inches multiplied by the constant 6,000.

Whenever possible a minimum of 17 teeth should be selected for the driver pinion in a speed-reduction drive. When a step-up drive is required, the smaller, or driven, wheel should contain a minimum of 21 teeth. In a speed-reduction drive the direction of rotation is not vital, but in a speed-increase drive the pull should be always on the top side when the centers are horizontal or nearly so.

In all chain drives it is preferable to arrange for center adjustment or, when the centers are fixed, to provide an idler to take up the slack of the chain occurring from wear. For the best results the construction on which the drive is mounted should be rigid and the shafts should be maintained in alignment if operating difficulties are to be avoided.

Lubricants properly applied are beneficial to all types of chains, and where the atmosphere carries dirt or grit, best results are obtained from the use of protective casings. These casings can be designed to provide an oil bath affording continuous lubrication.

Chain drives are finding application in ever-increasing numbers in all forms of industry. Internal-combustion engines, such as those used for automotive and marine purposes, are now almost universally timed, and the accessories, such as generators, pumps, etc., are operated by silent-chain drives. The intent of all chain manufacturers is to improve the product constantly in order to serve industry better.

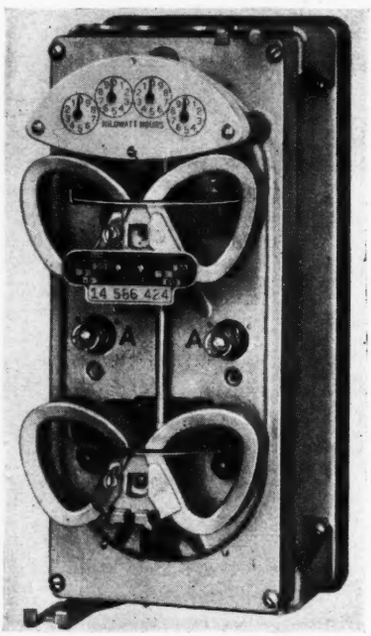
Potential Indicating Lamps for A.-C. Watt-Hour Meters

By H. S. Edgerly

Switchgear Engineering Department, General Electric Company

POTENTIAL indicating lamps are often mounted by the manufacturer in the cases of polyphase watt-hour meters. Some users, however, do not understand the function of these lamps, and operators have been known to complain, when taking a reading from one of these watt-hour meters, that the lamps were no good, as they did not illuminate the register sufficiently.

The function of these lamps is to indicate when potential is on the elements of the meter. There are at least three conditions that might exist in a polyphase circuit, any one of which would have the same effect on the rotation of the meter disk. There are three conditions under which the disk might rotate slowly: First, with light load on both elements; second, at low power factor; third, at low power factor with the element producing negative torque being dead because of the blowing of a fuse.



The lamps at A *indicate both meter elements are alive and are not to illuminate the register, as is sometimes assumed. If the lamps are dark, they are either burned out or the meter elements are dead*

In the first two cases the meter would be registering correctly the power flowing. In the third case, although appearing to function properly, the meter would not be doing so, as one element would be dead. This condition is objectionable and should be detected and corrected immediately. Such trouble is indicated plainly when potential indicating lamps are used, as only one lamp would be burning.

Steam Plant Power Dispatcher Prevents Losses

By Walter N. Polakov*
Consulting Engineer, New York City

PROPER TRANSMISSION, distribution and utilization of steam and power throughout the mill is as important to maintain as efficient and economical generation.

The more expensive the generation of steam and power, the more important is the efficient distribution and utilization. It is absurd, however, to economize on the generation and waste the savings in distribution and utilization.

Judicious and efficient dispatching of steam and power often permits increased factory operation without enlarging generating equipment. It leads toward correct pricing of finished product, particularly where several varieties of goods are processed.

No business house or bank will be satisfied with general ledger accounting, without customer's account. There is no more excuse to carry on power department business without keeping customer's account.

Steam and power dispatching is a service department which the power plant maintains for the benefit of its customers—manufacturing departments.

In an industrial power plant with a little over $20,000 monthly expense on power generation, the first year after inauguration of steam dispatching for distribution and utilization, with that work still in progress, the saving on record was in excess of $37,000. In a silk dye plant, with power expense from $35,000 to $50,000, annual saving due to such work averaged $20,000. Further references can be found in the articles entitled, "Allocating Power Costs to Product," Management and Administration, *June, 1926, and "Executive Control of Power Economy," published in the same magazine for September, 1925. Also description of my work at the Mount Hope Finishing Company, by H. M. Burke, entitled, "A Steam Loss Prevention Plan," American Society of Mechanical Engineers, 1923.*

Steam and Power Dispatcher

The steam and power dispatcher sees that all manufacturing and auxiliary departments served by the power house receive *all service needed, when needed, and that it is of required quality.* At the same time he sees that:

1. The power house is informed ahead of time of demand peaks.
2. Coincident peaks for steam in manufacturing departments are avoided, maintaining boiler load as evenly as possible.
3. Transmission and distribution are carried on with minimum loss, and maximum condensate is returned.
4. All steam and power delivery from the power house is accounted for.
5. Charges are accurately distributed for service to each consuming department.

Responsibility: He is responsible to the plant engineer, and reports to him directly. His office is located in the meter room, where all steam-flow meters, electric meters, etc., are placed on the panels.

Co-operation: He co-operates with:

1. The watch engineers as regards demands for various forms of power and steam anticipated, peak loads, stand-by and banked equipment, etc.

DISTRIBUTION OF POWER PRODUCTION EXPENSES
Total Power Expense to Operating Departments

Kind of Power	Total Steam Used	Unit Cost	Department	Per Cent	Charge
Refrigeration			Roll Celluloid	100	
Live steam				100	
			Manufacturing		
			Collar and cuff		
			Novelty		
			Specialty		
			Roll celluloid		
Electricity				100	
			Manufacturing		
			Collar and cuff		
			Novelty		
			Specialty		
			Roll celluloid		
			Brush and comb		
			Refinery		
			Machine		
			Administration		
Pneumatic				100	
			Manufacturing		
			Collar and cuff		
			Novelty		
			Specialty		
			Roll celluloid		
			Machine		
			Administration		
Hydraulic				100	
			Manufacturing		
			Collar and cuff		
			Novelty		
			Specialty		
Heating				100	
			Manufacturing		
			Collar and cuff		
			Novelty		
			Specialty		
			Roll celluloid		
			Machine		
Seasoning				100	
			Manufacturing		
			Administration		
Isolated steam plants				100	
			Manufacturing (880)		
			Brush and comb		
			Refinery		
Total power cost				100	
			Manufacturing		
			Collar and cuff		
			Novelty		
Total power charge to each department, all classes of service.			Specialty		
			Roll celluloid		
			Brush and comb		
			Refinery		
			Machine		
			Administration		

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2. The manufacturing foremen and production manager as regards their power and steam requirements.

3. The engineering department as regards the study and introduction of most economical utilization of steam, power, and light.

4. The accounting department as regards proper distribution of charges for service rendered.

5. The maintenance department as regards the maintenance of all transmission and metering equipment throughout the factory, including returns, traps, reservoirs, switches, valves, shafts, belts, etc., and all appurtenances; also, as regards the best operating condition of all machinery and equipment utilizing steam or power in any form, such as driers, heaters, boiling vats, frames, machines, radiators, accumulators, motors, and engines, located outside of power house.

Authority: The dispatcher has the authority to sign requisitions for such supplies and material as needed for maintenance and operation of meters and distributing apparatus in the dispatching room and throughout the mill. He also has the authority to sign requisitions for repairs and maintenance of all the equipment under his supervision, as indicated in Paragraph 5 under "Co-operation." These repair requisitions should be approved by the general superintendent. The dispatcher shall have the authority to supervise all maintenance work and new installations done on the equipment under his authority, and he has the right to suspend work if performed unsatisfactorily, referring it to the attention of the engineering department or general superintendent.

Routine: The routine functions of the dispatcher in discharging his duties consist of:

1. Planning the load for boilers and engines.

2. Continuously watching meter readings of steam-flow meters and electric feeders, and communicating by telephone immediately with the head of any department deviating at the time from anticipated consumption, in order to ascertain the cause, and prevent the loss or disorganization of any service.

3. He daily prepares steam and power dockets for each consuming department, and checks their total against the total of the power plant log.

4. He prices weekly or monthly the kinds of power and steam of various pressures, for the purpose of accurately charging the consuming departments for service.

5. He submits monthly, through the accounting department, complete statements of the steam and power distributed to various departments, indicating quantities used, charge for total service, unit cost and cost per unit of product processed in each department.

POWER DISPATCHER'S SUMMARY

FORM 501 — FOR WEEK / MONTH ENDING — MONTH | DAY | YEAR

GENERATED	M lbs.	DISTRIBUTED	M lbs.
Boiler No. 1 H R T 80 lbs.		Meter No. 6	
2		5	
3		4	
4		Total Live Steam to mill	
5		Meter No. 17 Exhaust Mill	
6 H R T 120		No. 3 Build Up	
7		Difference to Engines	
8		Total Steam	
9		Discrepancy %	
10		ELECTRIC CURRENT	
11 HEINE		Total KWH Generated	
12		Consumed by Mill Light Power	
13		Consumed by Village	
14		Total KWH Distributed	
15		Transm. & Transf. Losses	
Total Steam Made			
Feed Water Record			
Power House Use.....%			

ACT EVAPORATION EFFICIENCY %

DEPARTMENTAL CHARGES

Dep.		Meter	Lbs. Total	Kind	Price M	Total Charge	Production	Lbs. yd.
2	Singers	21	%	E				
3	Mercerizing	19		E				
		---17		E				
		Dif. 1		E				
		plus 9		L				
		TOTAL						
4	Kiers	8		L				
6a	White Cans	19		E				
		---Dif. 1						
		TOTAL						
7a	Black Dye	7		L				
		plus 18		E				
		TOTAL						
12b	Calenders	25		L				
12c	Shed Cans	18		E				
		---14		E				
		TOTAL						
16	Power Plant			L				
	Other Uses							
	GRAND TOTAL & AVER.			L-E				

PRODUCTION STATISTICS

	TOTAL		COST	UNITS	
				Lbs.--yd	Mlbs.--yd.
Aver. yds. in Process	yds.				
Total Steam Used	lbs.	$			
Total Fuel Consumed	lbs.	$			

Power Dispatcher

Handling the Peak-Load Problem

VARIOUS METHODS *of carrying peak loads are discussed and their adaptability is analyzed.* DIESEL ENGINES, PEAK LOAD-UNITS, *and* STEAM STORAGE: *Each has particular adaptability under certain conditions. Steam storage offers large savings when the local conditions are favorable; it is being widely adapted in Europe and to some extent here.*

BY A. G. CHRISTIE
Professor of Mechanical Engineering
Johns Hopkins University, Baltimore

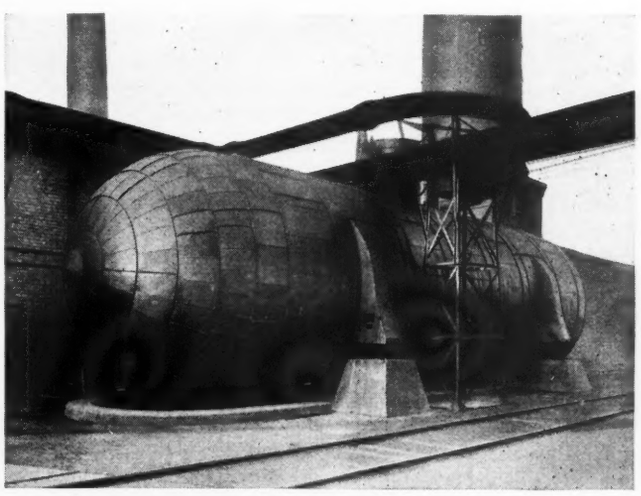
SHARP daily peak loads and seasonal peaks present problems to both the operating and the designing engineer. The former finds that such peaks cause his stations to operate at low-load factors and that much reserve equipment must be maintained for operation for a few hours per year on the peaks. The latter must consider the effect of low-load factor on total station costs and must plan to provide low-cost equipment for peak-load service. Rapidly growing systems, particularly those with sharp daily peak loads, present particular problems, for old plant equipment may not be sufficient to carry peak load. The question arises whether it is possible to meet the situation by some type of lower-cost plant other than standard turbines and boilers. This can be done either by a simple peak-load turbine plant or by the employment of steam storage, which, in some cases, offers the lowest total plant cost for peak-load service.

I have advocated for some time the more extended use of the annual load-duration curve[1] as an effective means of presenting the system's or plant's yearly output in graphical form. It is particularly useful for the analysis of peak loads. A study of the average load-duration curve emphasizes the few hours of service and the small output in kilowatt-hours of such portion of the plant equipment that may be reserved for carrying the annual peak load. If the peak load of the plant were considered an entity by itself, with the fixed charges and operating costs of this portion charged against its commercial output, the cost of this portion of the station output would be extraordinarily high. The operating costs per kilowatt-hour on the peak-load portion are usually a small fraction of its fixed charges, for it operates so few hours per year that even its extensive standby periods do not result in high operating costs. This leads to the conclusion that a peak-load plant should be installed at the lowest possible first cost to reduce fixed charges and that the economy of this portion of the plant can be sacrificed to secure low investment. With these premises granted, the various schemes for carrying peak load may be discussed and critically analyzed.

Consideration of the problem indicates that there will not be a single method of carrying peak loads that will have universal application. This is due to the varying characteristics of the electrical loads on the different systems. One system may have a large residential load and furnish little commercial or industrial power. Its load curves will be characterized by sharp daily peaks rising to an annual peak shortly before Christmas. Another system may have a large power load and other demands so diversified that there is no sharp daily peak. The load on such a system may gradually increase as a whole to a broad winter peak and fall off again in summer. These two systems, with widely differing characteristics, would therefore require quite different peak-load equipment.

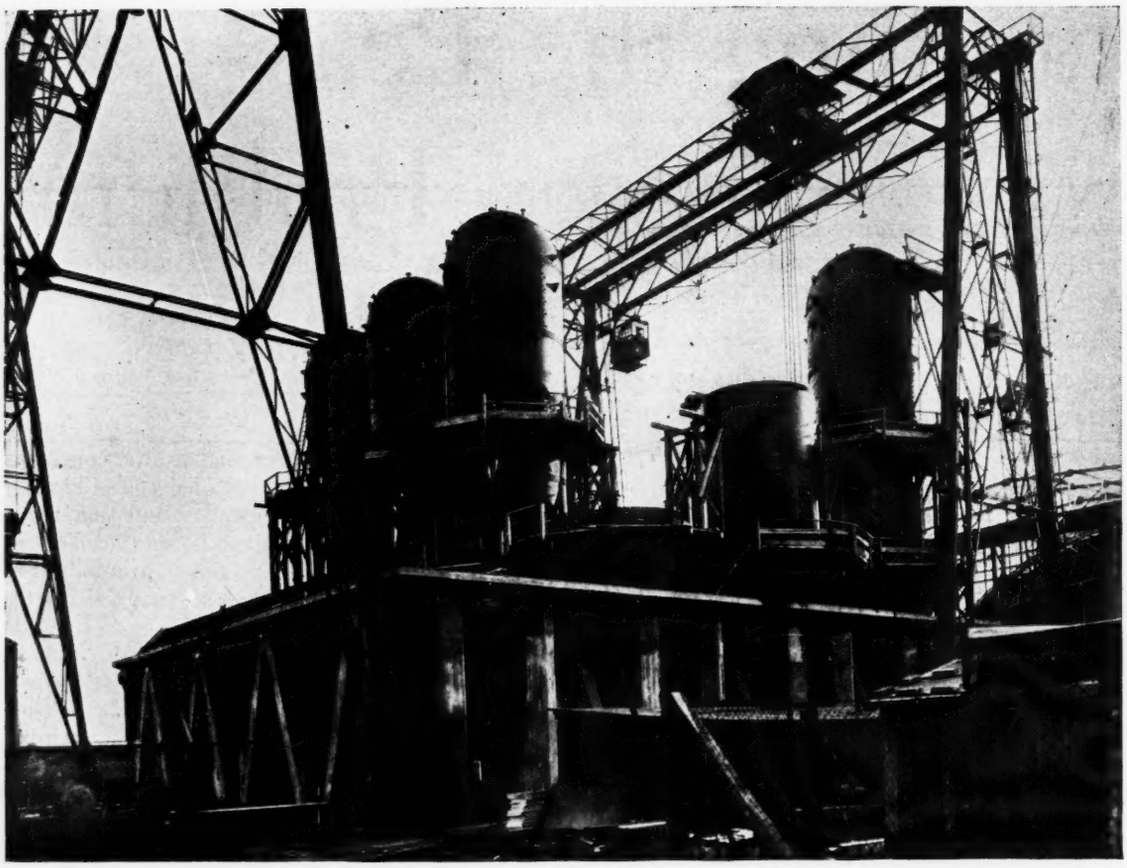
HYDRAULIC STORAGE

Density of population, riparian rights and opposition to flooding of agricultural lands have resulted, in certain cases, in hydro-electric developments with little or no water storage and often with comparatively low heads. The total plant capacity must equal the yearly peak demand if no steam reserve or interconnection is provided. A greater portion of this capacity is idle at other times. Hence, much water goes to waste. If conditions are favorable, hydraulic storage has permitted such plants to increase their peak-load capacities. Off-peak power is furnished either directly or through motors to high-head centrifugal pumps, which deliver water to a large reservoir located on an adjacent height. This stored water is discharged at the time of peak load from the reservoir through special high-head turbines, which generate power in addition to the normal turbines. The idea has been used in a number of plants in Europe, and in some in this country.



Standard horizontal Ruths accumulator

[1]The construction, interpretation and application of load-duration curves are explained in the writer's A.S.M.E. paper on "The Peak-Load Problems in Steam Stations."



Vertical accumulators being built at Charlottenburg, Germany

The efficiency of this system expressed by the ratio of the electrical output of the high-head turbines to the horsepower available from the head and from the water used by the low head turbines, which drive the centrifugal pumps, ranges, under favorable conditions, from 50 to 60 per cent but is often as low as 40 per cent. The economy of this plan depends on local conditions, which determine the availability and cost of storage reservoirs, pipe lines and load demands. The cost of European plants ranges from $50 to $375 per kilowatt of final output. The fixed charges on the European systems vary from 9 to 11 per cent per annum, but they probably would be higher in this country.

It is doubtful, however, whether hydraulic storage will ever be adapted widely in this country, because few hydro-electric plants are located where high-head storage basins could be constructed, and many of our rivers have seasonal flow, low-head developments, with small storage reservoirs.

Hydro-thermal Storage

It has been proposed that available off-peak hydro power, when there is no river storage, be furnished to electric boilers—often in conjunction with high-pressure steam accumulators. Peak-load demands would be met by discharging this stored energy through steam turbines. While the efficiency of electric boilers is high, the over-all thermal efficiency of a steam turbine plant working under these conditions would not exceed 20 per cent. In other words, allowing for radiation, auxiliary power and other losses, probably about only one-sixth of the energy that was supplied to the electric boilers could be regained. This is a low over-all efficiency and could only be justified under unusual conditions, as on an isolated hydro system with no site for hydraulic storage and with short, sharp peak-load demands. When this steam can be used for some industrial purpose instead of for generating power, it is often economical to store and utilize off-peak power in this manner. There are a number of such plants in Europe.

Storage Batteries

Electric storage batteries are used to carry peaks on portions of the load served by direct-current distribution. American utilities find that direct current has its limitations and that the growth of such load results in too great an investment in copper. The present tendency is to limit the growth of direct-current distribution and to replace it wherever possible by alternating current. The losses of conversion and charging appear to make it impractical to use storage batteries for service with alternating-current distribution.

Large storage batteries require much floor space. They must have charging equipment and switching apparatus, which increases the investment. Such batteries require much maintenance, as replacement of plates and separators, cleaning cells, checking acidity, and control of charging and discharging. The fixed charges and maintenance on a battery plant are high. In America the use of large storage batteries for system peak loads is now seldom considered.

Large Diesel Engines

The hard, steady service demanded of Diesel engines in marine service indicates that modern slow-speed engines of large size which are reliable and can operate for long periods with small maintenance are now available. Higher-speed engines have been offered for short

periods of peak-load service. They can be started up quickly, and there are no stand-by charges during off-peak hours.

The *Engineer* (London) March 2, 1828, reports that it has been found profitable to install two 7,500-kw. Diesel engine sets for house and peak load service in a large German steam station using brown coal costing only 60 cents per long ton. By using the Diesel engine sets to take the peaks, the load factor of that station is to be increased 10 per cent. With fuel oil costing $32.50 per long ton, current will be generated at 1.5 cent per kilowatt-hour. The oil engine sets will pay for themselves in five years.

The place of Diesel engines for peak-load service in an electrical system would be at some outlying load center. Such engines could be started quickly and their use would relieve the distribution system of the line losses to this outlying center.

Old Plants for Peak-loads

The practice of relegating old generating equipment on the system to peak-load service is good engineering provided the costs of maintaining this equipment are not unreasonable. This is the orthodox use of older equipment in America. The rapid growth of many power systems and the higher efficiencies now possible by base-load operation of plants designed for regenerative feed-heating and for high initial steam pressures and temperatures, have made it necessary to allocate turbines and boiler plants to peak-load service at a relatively early age. It is frequently questionable whether it would not be more economical to retain this higher-priced equipment in regular service for a longer period by providing some other type of plant at lower cost for peak-load service.

Peak-load Steam Units

A specially designed turbine and boiler plant for peak load service only would contain rugged few-stage turbines of high capacity and low first cost. The boilers would have big furnaces, with water-cooled walls for either oil or powdered-coal firing. These could develop large steam output for short periods over the peak-load, though at lower efficiency than standard units.

Such peak-load equipment appeals to many engineers, for it can be used as a reserve for service in emergencies at other times that at peak load. On power systems without sharp daily peaks and where the load as a whole rises to an annual peak, this equipment appears to have certain advantages.

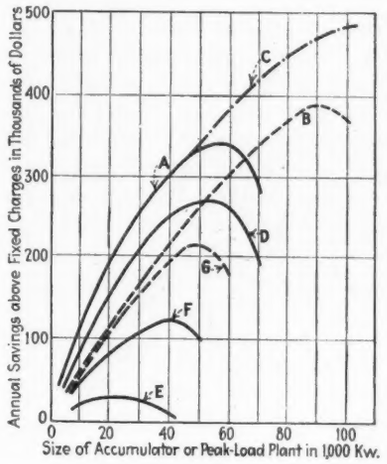
Steam Storage

Steam storage has been used for many years in industrial plants for process work. Various applications of steam accumulators for these purposes have already been described in technical papers. The economic possibilities of steam storage in connection with central stations to carry peak loads are not generally recognized in America, notwithstanding the fact that fourteen European stations are so equipped.

The equipment used for peak-load service in these European central stations, consists, in general, of a set of high-pressure steam accumulators which may be charged with steam during the night and during periods of low load. This method of charging results in an improvement in boiler operation by steadying the output, and it increases the boiler room efficiency. The stored steam can be discharged through a special turbine to carry the peak of the load. The set is also available for emergency conditions such as thunderstorm peaks, breakdown in other plant equipment, etc.

Steam storage can be advantageously installed in plants carrying loads that fluctuate rapidly over wide ranges, as in plants for hoisting service, in railway electrification and in street railway service. Mixed-pressure turbines may also be employed which can run on steam either from the boilers, from the accumulators or from both. The accumulators in plants with fluctuating loads carry all load above the average and store excess steam at all loads below average. The boilers thus operate at almost constant load, which increases efficiency, whereas violently fluctuating loads are hard to handle on the boilers and lead to inefficiency.

The largest installation of accumulators for peak-load service is at the Charlottenburg plant, Berlin, Germany.



Annual savings through use of steam accumulator or peak-load unit on a 200,000-kw. system with 45 per cent annual load factor and $5 coal

Curve A—Annual savings, steam accumulator over addition of base-load plant to standard plant.

Curve B—Annual savings, peak-load unit over addition of base-load plant to standard plant.

Curve C—Annual savings, combined accumulator and peak-load plant over addition of base-load plant to standard plant.

Curve D—Annual savings, steam accumulator over addition of standard unit to standard plant.

Curve E—Annual savings, steam accumulator over addition of base-load unit to system with standard plant and old low-efficiency plant.

Curve F—Annual savings, steam accumulator over addition of base-load unit to system with standard plant together with older plant of moderate efficiency and still older plant of low efficiency.

Curve G—Annual savings, steam accumulator over addition of base-load unit to system with a series of units with efficiencies decreasing from the standard plant to the very old plant.

Note: The differential between curves A and B at any size of accumulator or peak-load unit remains constant for that particular size. Curves have not been drawn for annual savings with peak-load units for conditions represented by curves D, E, F, and G, as this would confuse the diagrams. The savings by the use of peak-load units with these combinations can be found by deducting the differential between curves A and B from the curve of accumulator savings for the particular system in question.

Sixteen vertical Ruths accumulators 14 ft. 9 in. average diameter and 69 ft. high are being installed. This equipment is here shown under construction. These accumulators will furnish steam to two 20,000-kw. turbines at the time of peak load and can deliver 70,000 kw.-hr. The turbines are double-flow reaction units with suitable valve gear for the decreasing accumulator pressure. This plant will be completed this summer and will carry peak loads next fall. The other thirteen European installations are of lesser individual capacities.

The installation of accumulators at Charlottenburg was

decided upon only after a long and exhaustive study of the Berlin peak-load problem. Two factors appear to have influenced this decision, first, the satisfactory performance of earlier accumulators in central stations, and second, the low first cost of the steam-storage system. Dr. F. Munzinger, of A.E.G., Berlin, Germany, stated in his paper on "Fuel Control in Electric Power Stations," in the *Journal* of the Institute of Fuel, October, 1928, that "The initial cost of accumulators per kilowatt of output, including the corresponding turbines, piping and buildings, is about £8 to £9 ($39 to $44) compared with £12 to £14 ($58 to $68) for corresponding standard boilers and turbines."

While accumulators for central station service could be built for quite high pressures, the economical operating limit appears to be about 175 lb. when completely charged and 20 lb. as the discharge pressure. These limits are dependent upon first cost, size and local conditions.

The possible savings by the use of steam storage for peak-load service were discussed quite fully in my A.S.M.E. paper referred to previously. Certain power plant costs were taken based on actual American plant costs, and daily and annual load curves were assumed for 25, 45 and 65 per cent annual load factors. The installation of either peak-load units or steam accumulators in place of additional base-load units of equal capacity was analyzed and the savings by both methods were calculated. Reference can be made to the A.S.M.E. paper for full details of this analysis. The curves reproduced from this paper show the savings that may be secured by the installation of a steam accumulator unit in place of the base load unit under the given conditions, with the assumed load at 45 per cent annual load factor. This and other curves indicate that large annual savings are possible through the use of a steam storage plant to carry a portion of the annual peak.

These studies indicated that steam accumulators have advantages in the case of systems with short, sharp daily peaks. Pead-load units are preferable where the annual peaks are broad and of long duration. Steam accumulators would make their greatest savings when added to the most modern plants, for the added savings by new base-load units would not be so great as with older equipment. The lower the annual load factor of the system, the greater is the saving that can be made by the steam accumulator plant. Finally, the lower the price of coal the greater the accumulator saving, for the fuel savings of the base-load unit would be worth less. It would appear that steam storage should effect large savings when utilized to carry peak loads where the load factors are low, plants modern and coal cheap.

Unlike central stations, where the production of kilowatt-hours is the prime objective, the INDUSTRIAL POWER PROBLEM concerns more than mere generation of power. Closely interwoven with the production of power is the supply of various plant services, of which process steam, in many industries, is the dominating factor. So important is this, that the

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will be devoted largely to discussions of various phases of this subject. It will contain much of helpful interest to those plant executives and operatives who contemplate rehabilitating their plants along lines comparable with the most MODERN PRACTICE.

Aging of Insulating and Steam-Turbine Oils

Description of testing method devised by Dr. Baader which avoids errors involved in the usual methods of measuring the tendency of oils to deteriorate

By H. L. Kauffman

AGING of an oil is essentially an oxidation process, which is accelerated by elevated temperature and by contact with certain materials, especially metals. Baader points out ["Elektrizitätswirtschaft," Communications 461 and 463, June, 1928] that there are two fundamental errors in present methods of measuring the tendency of oils to deteriorate in use. The first is that all the causes of aging are allowed to act in combination upon a single sample of the oil being tested. The result is that the refiner does not know how to correct the technique of the refining process so as to produce an oil better adapted to its intended use. A lead-sensitive oil could be used in lead-free units; a temperature-sensitive oil where the temperature is always under 55 deg. The second error is that movement of the oil while the test is in progress is entirely neglected; with the result that, in order to accelerate aging, air or oxygen must be conducted in or pressure applied, thus introducing conditions different from those under which the oil is normally used

Description of Apparatus

A testing apparatus which avoids both errors is described by Baader. Four samples of the oil, held at the same temperature (95 deg. C. or 203 deg. F.) in a thermostat, are stirred continuously for 48 hr. One stirrer consists of a glass spiral, one of lead, one of copper, and one of iron or of steel. At the end of the period, the saponification number and sulphuric acid reaction are determined for each sample of oil. The two determinations together require but a small fraction of the time and expense necessary for a tar-number determination. The saponification number for the sample stirred with a glass spiral minus the saponification number for untreated oil represents the heat-sensitiveness of the oil. The saponification number for the sample stirred with iron minus that of the sample stirred with glass represents the iron-sensitiveness of the oil. Copper-sensitiveness and lead-sensitiveness are found similarly. So also a set of sensitiveness figures is obtained based on the acid number found for each sample.

The acid number is obtained by shaking 10 c.c. of the oil with 10 c.c. of 96 per cent sulphuric acid, letting it stand for three hours and reading off the increase in volume of the acid. The acid numbers found by Baader were low, making the percentage of error high.

The sensitiveness estimated from the acid number did not always accord with that based upon the saponification number. The acid number has for its basis only a part of the products of aging. Iron-sensitiveness is probably independent of temperature sensitiveness. Fifty per cent of the oils tested were copper sensitive, 67 per cent lead sensitive. There is reason to believe that lead sensitiveness is acquired in some way in the refining process and can therefore be prevented. An oil refined by the present-day Edeleanu process did not age half as rapidly as a sulphuric-acid-refined oil from the same crude.

Right Out of the Plant

Factors to Be Considered When Changing From Live to Exhaust Steam for Process

WHILE much has been written on the subject of using exhaust steam in the place of live steam, consideration of the following factors may be of some help to others about to make the change:

First of all have a definite plan. Then make sketches of the changes proposed in the various departments or processes, and figure your costs in detail.

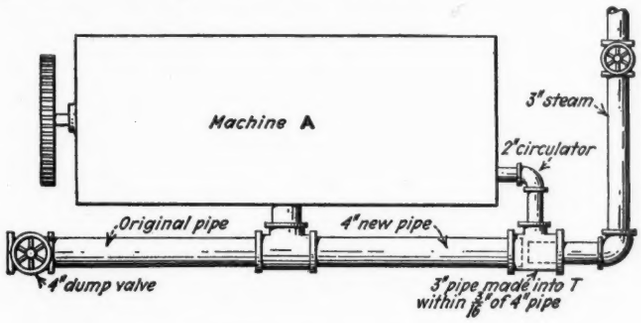


Fig. 1—Changes made for heating water in machine with exhaust steam

Naturally, you must run your mains or headers first. By all means have your mains large enough. Avoid running small pipe any great distance. Naturally, you start the change-over in the departments nearest your source of supply of steam. This, of course, enables you to keep the money invested in mains at a minimum and at the same time bring in some return. However, circumstances alter cases. For instance, a certain department had several large tanks that required heating from 60 to 200 deg. about four times a day. It required about fifteen minutes to do this. The nature of process was such that the tanks had to be heated together. Obviously, the load factor on this piping would be extremely low. However, the effect on the boilers warranted changing this department immediately. This load came at the peak of the boiler load, which necessitated further driving of overloaded boilers. By changing this department to exhaust steam this heavy peak was eliminated.

Sometimes the question of salvage dictates the department to change over first. There may be certain departments that could be equipped with material salvaged from another, such as valves, fittings, traps, etc. Buy new material for the first department, salvage its material, then proceed with the second.

In one instance we bent all our efforts on a certain department having a number of high-grade traps. These traps were badly needed to replace other traps that were ready for the scrap pile. For exhaust we used a thermostatic trap worth $8 to replace these traps that cost $28.

In another instance we salvaged considerable 3-in. pipe and covering that had been in use 25 years. Some doubt was felt as to its fitness, but when it was taken down it was found to be in excellent condition. It was wrought-iron pipe with magnesia covering.

Be sure to select a trap that will positively remove air and do it quickly. The greater part of our troubles have been due to air in the system. Be sure and install an automatic air vent at the top of each riser.

Do not make the mistake of trying to use the same piping for exhaust that was used for high pressure. If it takes ten minutes to heat a quantity of water for process with high pressure, by all means heat it in eight with exhaust, especially when you first start to change over. The operators, naturally, are opposed to any change in their routine. Do not give them the opportunity to say it slows production. For instance, in a certain process using live steam at 60 lb. the water was heated by blowing the steam directly into the bottom through a $\frac{3}{4}$-in. pipe, taking about five minutes to bring it to 120 deg. For safety a 3-in. line carrying 5 lb. pressure was used. The method of connecting the line is shown in Fig. 1. This simple, practically silent, device, in eliminating the noise caused by boiling the water, more than repaid the labor put into it.

Do not overlook having plenty of hot water to start a process. For instance, we have a great number of small dye kettles. The procedure was to fill them with cold water and bring them to a boil, which required thirteen minutes. By piping hot water to these kettles the time was cut to three minutes. While some money was saved on steam, it so speeded up production that its cost was insignificant.

We have a 10,000-gal. storage heater for hot-process water. On starting in the morning, it condensed all the steam the turbine produced for the first hour. This, of course, left the low-pressure system without any steam during that time. Obviously, a reducing valve would have to be installed to supply makeup. However, by changing the back-pressure valve as shown in Fig. 2, full pressure is built up in the system immediately. Conditions are such that the change had no bad effect on the performance of the heater. In fact, this heater is the shock absorber of the low-pressure system. It can condense large quantities of steam when it is available, and it has sufficient storage capacity to supply hot water when the exhaust is needed elsewhere.

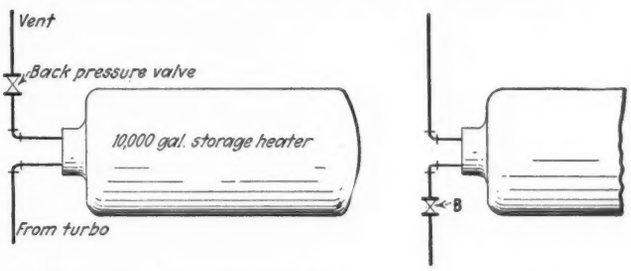


Fig. 2—Back-pressure valve was changed from discharge to inlet side of storage heater

Determining the most suitable back pressure is a vexing question and one that requires plenty of study. Naturally, your prime mover will carry more load or do it more economically at low back pressure. The processes will undoubtedly operate better at a higher pressure. Costs of piping systems will enter into consideration. Right here a definite plan with accurate costs is indispensible.

Faced with the problem of additional load in the immediate future, together with raising our back pressure, we were, fortunately, ably to raise our boiler pressure. As we are now at the limit on these boilers, we contemplate installing superheaters when conditions justify it. We figure, in addition to increased output, to superheat high enough to carry a few degrees of superheat into the exhaust.

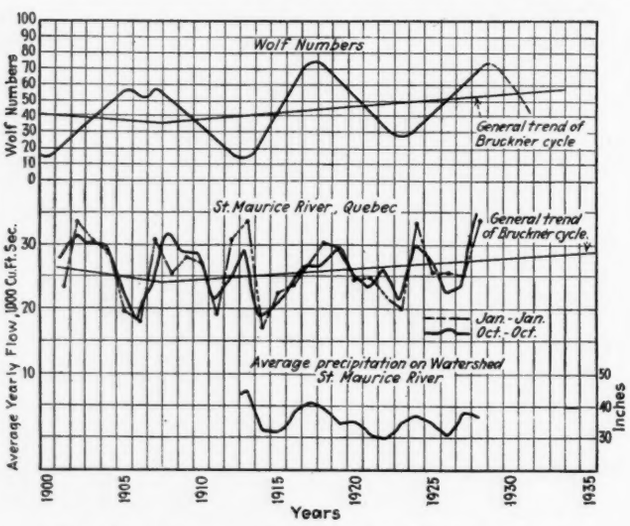
Another consideration is the location of reducing valves to admit live makeup steam into the exhaust system. It may be that a certain department uses a fairly constant amount of steam for practically most of the day but has a short peak load using, say, double this amount. To put in a main large enough to supply this peak (even if you had the steam) would be tying up money needlessly. Install a main ample to supply the normal demand, then bleed high-pressure steam into the exhaust during the peaks. Place the reducing valve as close to the point of consumption as possible. Less money will then be tied up in piping. During the peak the high-temperature steam entering the system keeps up the pressure and boosts the temperature in most cases a desirable combination.

If you have any dry rooms you contemplate changing over, it will pay to investigate the unit heater, with either temperature or humidity control or both. However, be sure to provide ample radiating surface. A little too much simply means the fan will be idle a great part of the time; while if too small a unit is used, trouble will be encountered, especially in cold weather.

Watertown, Mass. THOMAS A. WALSH.

Predicting Stream Flow for Power Generation

AS MR. STREIFF has pointed out in his articles in *Power*, April 16 and 30, on predicting stream flow, engineers have been in the habit of basing their calculations on average figures obtained from data of a few previous years. Also, they have been more or less content with the fact that high or low stream-flow years would occur in the future at more or less uncertain periods. When examining stream-flow and precipitation records, it has been noted that certain cycles of high and low flow occurred, but that they were not, apparently, consistent nor could any definitely accurate attempt be made to forecast future occurrences, owing to the lack of a known base to work from. The cycle of maximum and minimum sun spots apparently furnishes such a known base, and by extrapolation it may be possible to obtain a fairly accurate measure of future conditions. The value of this will be immediately apparent to those in charge of hydro-electric enterprises.



Relation between St. Maurice River flow and Wolf numbers

Wolf numbers are an index introduced by the late Professor Wolf, to measure the relative abundance of the sun's spots.

The relation between the maximum and minimum sun spots and river-flow data does not in all cases obey the same laws. It is necessary in each location to establish some relation between the two factors that will be more or less consistent.

The curves in the drawing show the relation between the St. Maurice River flow and Wolf numbers and between precipitation records and these numbers. While certain relations exist, they are not quite so distinctly apparent as similar data on the Muskegon and the Winnipeg rivers.

W. R. WAY,
System Operating Engineer,
Shawinigan Water & Power Company.
Shawinigan Falls, Que.

Cooling-Water Problem With Large Gas Engines

SOME years ago a company manufacturing gasoline from casing-head gas decided to put in a central power station and run its several compressing stations with motors instead of individual gas engines, and it fell to me to operate this central station.

There were two direct-connected gas-engine-driven units in the station, and the cooling-water had to be pumped about a half mile from a river. As the river flowed through the oil country, it was badly contaminated with salt water from the oil and gas wells. This salt did not necessarily hurt the water for cooling, but anyone who has handled large double-acting gas engines, with all their intricate water connections, knows how hard it is to keep all these connections tight, water from a leaking connection usually finding its way into the oiling system. The oil is soon contaminated.

The exhaust pipes and manifolds in this plant were water cooled, and as there was always more or less leakage the resultant salt vapor escaping into the engine room and being drawn into the generator windings caused moisture to precipitate in foggy weather to such an extent that it was possible to scrape off large drops from the coils. The trouble finally became so serious that a short circuit developed in one of the machines and several coils were burned out.

Almost anyone would say that the thing to have done was to tighten up the manifolds and keep the vapor from collecting. But this had been tried. The conditions at this plant were such that it was impossible to keep them tight enough to prevent some vapor escaping.

One of the electricians finally recalled how a similar situation had been handled at another plant. At his suggestion a gas burner was piped up in each generator pit and kept burning in damp weather. The heat from the burners kept the generators so warm that moisture would not precipitate, thus effectually stopping the trouble.

EARL PAGETT.
Coffeyville, Kan.

The Air-Flow Steam-Flow Meter as a Boiler Control

THE operating engineers who so far have expressed their opinions in *Power* on the air-flow steam-flow and the CO_2 meters are unanimous that the Orsat is necessary; but there seems to be quite a diversity of opinion as to the necessity of the CO_2 recorder.

The analytical method is the only scientific one for diagnosing and controlling boiler operation, and CO_2 is the fundamental control factor. It is the only factor that by itself gives reliable information. It is a true index of excess air, which is the cause of the bulk of the avoidable heat losses in boiler operation.

The air-flow steam-flow method of control combines two records—neither of which, by itself, has any control value—in such a way that when the records coincide the boilers will operate in the most efficient manner. But it is based on the two erroneous presumptions that air is equicalorific and that complete combustion means maximum combustion and absorption efficiency. Maximum combustion efficiency does not result until the heat loss increments of one per cent of CO_2 increase, due to the corresponding rise in CO, equals the heat loss decrements due to the decrease in the percentage of excess air. Air is equicalorific only when its oxygen is completely burned with a given fuel. The heating value of the air supplied decreases as the percentage of excess air increases; CO_2 being the index of excess air, is therefore the index of its heating value. Since the heat input minus the heat wasted up the chimney plus radiation must balance the heat in the steam produced, it follows that when the steam-flow record falls below the air-flow record, either the heating value of the air must have fallen below the maximum value for which the air meter was adjusted or the heat loss up the chimney has risen above normal, or both. To bring the records together again the heating value of the air must be increased, which is accomplished by decreasing the percentage of excess air. If the drop in the steam-flow record below the air-flow record is due to a reduced heating value of the air, caused by excess air, then the records will come together again as soon as the excess air has been brought down to normal. But if the decrease in steam flow is due to abnormal gas temperature caused by dirty heating surface and resulting in excessive heat loss, the excess air will have to be reduced below that required to secure complete combustion, and incomplete combustion will result. Leaky baffling also causes excessive gas temperature, which must be balanced by increasing the heating value of the air or by burning more fuel. The air-flow meter is thrown out of calibration in either case, and combustion is out of control unless a CO_2 recorded is provided.

On the other hand, when the steam-flow record rises above the air-flow record more than the normal weight of steam is produced per pound of air supplied; that is, the heat output is greater than when the records are together. To bring down the steam-flow record to coincide with the air-flow record, the heating value of the air must be decreased by increasing the excess air sufficiently to absorb and carry to waste as much heat as was absorbed by the boiler in generating the increased flow of steam that carried the steam record above the air record. In other words, when the steam-flow record rises above the air-flow record the two cannot be brought together except at the expense of boiler efficiency. The heat must also be wasted that was brought to the boiler owing to a rise in temperature of the air and feed water above that prevailing when the air meter was adjusted. This is the greatest fault of the synthetic method of control, and it is also its salvation. The synthetic method would not be workable if complete combustion were synonymous with maximum combustion efficiency attainable under any given operating condition.

No one instrument is sufficient for the control of boiler operation. This was recognized early, so the designer added the temperature recorder and the multiple-draft indicators. With these additions and with an Orsat the air-flow steam-flow record can be interpreted fairly well.

With hand-fired boilers the CO_2 recorder, which makes a continuous record, has a decided advantage, because it marks definitely the firing intervals and the time the firedoors were kept open. This is an important check on the fireman.

E. A. UEHLING, DR. of ENG.

Milwaukee, Wis.

Industry Must Help the Schools in Research

Just a short time ago the head of the engineering department of a college told a group of men that the present-day industrial research man is far ahead of the college professor in technique and knowledge along many lines.

The research laboratories of large corporations such as General Motors, Bell Telephone, General Electric, etc., are far ahead, in equipment, scope and achievement, of those of universities; and the logs of their experiments and work contain data that will not get into textbooks for several years.

This is due, of course, to the large appropriations of these corporations for research along their special lines, the continual attention year after year to these same endeavors and the devotion of twenty-four hours a day to the given subject without diversion. The college professor must teach, and can devote only a small portion of his time to research, and then must divide this short period among almost all phases of his branch of engineering. The appropriation for his "pet" researches are quite limited.

The industrial plant must obtain its supply of personnel from the university, and unless the student is trained along the lines of work desired he must receive instruction at the plant. It then behooves industry to help the schools in research, not only morally but "with a more effective collaboration."

It is of course, impossible for college professors to take courses in these laboratories, or for the industrial research executives to join the school faculty and give demonstrations and lectures to the students, desirable as this combination might be.

It is not, however, impossible to take the student to the plant for part-time participation in the work of the industrial factory. This has been accomplished by the co-operative courses given by so many universities, where students alternately attend school and work in the factories, shifting every month or so. The student gets paid for his working time, and assists in meeting his own expenses, while his actual shop experience fits him for a job.

This short comment had its inspiration in the discussion in the May 7 number of *Power* regarding W. E. Wickenden's article on the same subject.

Dayton, Ohio. C. W. STEVENS.

What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

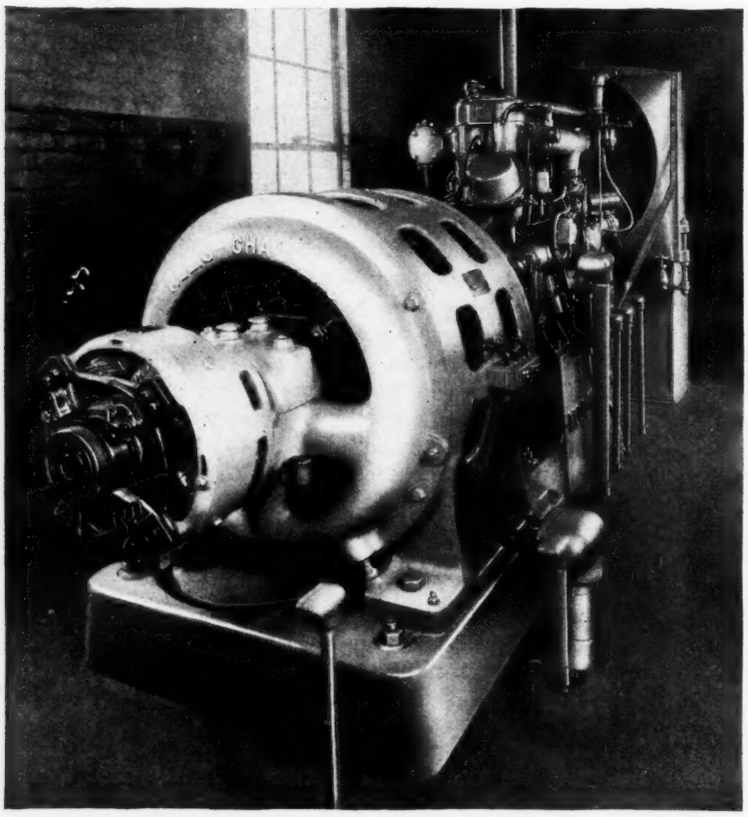
Gasoline Engine Generating Units for Emergency Service Operate Automatically

ALTHOUGH developed primarily for service in the mining industry, the line of automatic gasoline engine generator sets put out by the J. H. Weir Company, Wilkes-Barre, Pa., has been extended to include units up to 275-kw. capacity. In addition to the generating units, the automatic gasoline engine can be furnished direct connected to a centrifugal pump or other unit which may be ordinarly operated electrically and to which it is desired to connect a prime mover to operate automatically.

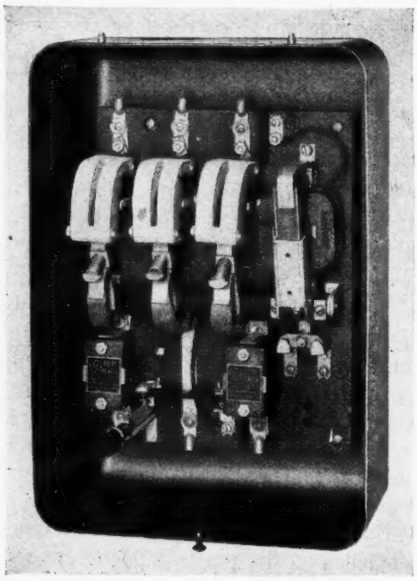
In the generating set illustrated the engine is a Sterling four-cylinder heavy-duty marine unit designed to operate at 1,200 r.p.m. The generator is an Allis-Chalmers 480-volt, 60-cycle machine, with direct-connected exciter. The engine control equipment, which is designed to start the unit when the primary supply of power fails and to shut it down when service is again restored, is built by the Cutler-Hammer Manufacturing Company.

The engine is equipped with three spark plugs per cylinder, each fed by a separate system of ignition. It has dual overhead valves for both inlet and exhaust and a governor to maintain uniform speed.

To assure quick starting, which is an important feature of the unit, the engine is fitted with an electrically operated primary system, which injects a high-pressure supply of primary fuel into the cylinder intakes during the starting period. When necessary or desirable for operation in cold weather electric heaters under the crankcase prevent thickening of the crankcase oil. The engine control equipment is operated from a twelve-volt storage battery, which also supplies the current for cranking and ignition. The unit illustrated is designed to come to speed and take full load in fifteen seconds.



Automatic generating unit for emergency service



Switch with cover removed

Magnetic Switch for Across-the-Line Starting

THE magnetic switch illustrated, which supersedes a previous model of the same type, is designed especially for throwing small motors directly across the line. It can also be used as a primary switch for slip-ring motors having secondary control.

The improvements in the new switch over the former model includes the use of a molded shaft which will not stick in the bearings, thermal overload relays with interchangeable heater units, silver contacts on the holding interlock, an E-frame magnet which requires a minimum of power to operate it, and restricted type blowouts. The enclosing case is of the drawn-shell type. The reset button for the overload relays extends through a hole in the cover, allowing its use without removing the cover.

The horsepower ratings at various voltages for the standard squirrel-cage type of motor are as follows: 110 volts, 7½ hp.; 220 volts, 15 hp.; and at 440 and 600 volts, 15 hp. For straight starting duty where no jogging is encountered the rating on the 440- and 600-volt switch can be increased to 20 horsepower. The switch is put out by the General Electric Company, Schenectady, N. Y.

Thermo-Hydraulic Feed-Water Regulator

IN THE thermo-hydraulic feed-water regulator illustrated, brought out recently by the Bailey Meter Company, Cleveland, Ohio, the feed, or regulating, valve is fitted with "V" ports designed to give changes in rate of flow proportional to the valve opening at any point, and to be

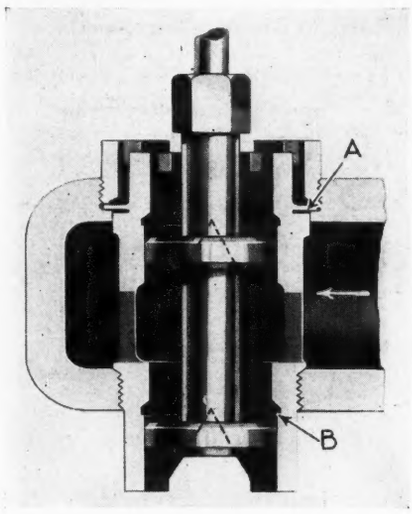


Fig. 1—Section of valve showing recesses below seats and cage sealing flange

tight seating, thus insuring control of banked boilers and freedom from flooding when operating at low ratings.

The regulator consists essentially of three parts, a generator to supply the pressure for operating the control valve, a bellows-operated regulating valve and interconnecting tubing or piping. The generator, which is connected to the boiler at the water level, embodies a main pressure generating unit, a cold water storage leg, a condensate bypass and a vacuum seal. The generator is of welded construction and is furnished as a complete assembled unit. For boilers operating at pressures above 400 lb., the generator assembly is made of heavy wall steel tubing, with welded joints and flanged connections.

The design of the regulating valve is such that it may be placed in a vertical or horizontal pipe line at a point either above or below the boiler water level. The valve, which is fully balanced, is opened by a four-ply bellows in response to pressures exerted by the generator and is closed by a coil spring mounted on the spindle. The valve cage is of one-piece construction and is screwed into the lower inner wall of the valve body, while the top of the cage is made tight in the body by means of a sealing flange *A* and a clamping nut. This construction provides for any differences in expansion or contraction between the cage and valve body and precludes the possibility of distortion of the valve seats.

Another important feature of the valve design is the use of the recess *B* at the bottom of the 45-deg. angle seats in the cage. The function of this recess is to distribute the flow evenly around the disk when the valve is operating near the closed position and to prevent the cutting of the disk and seat by wire drawing at the tips of the "V" ports. Should

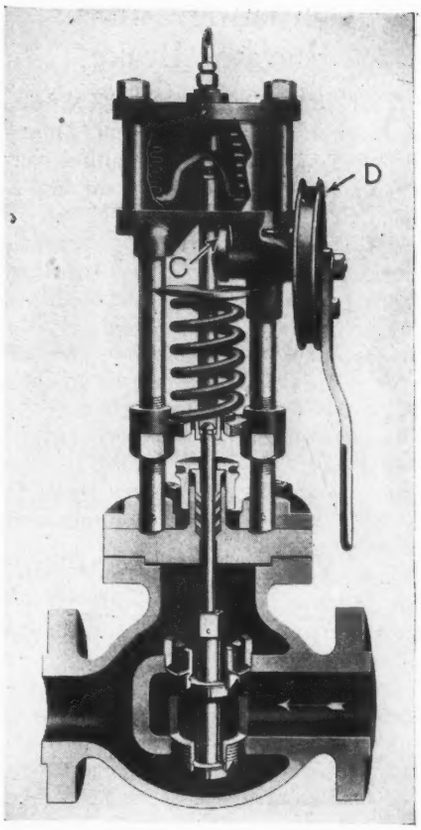


Fig. 2—Valve with operating mechanism

it become necessary for the seats to be reground or replaced the entire valve cage can be removed from the valve without removing the valve body from the line. This design, in which the entire balanced valve mechanism is contained within the cage, eliminates the necessity of having to remove the valve body for any work on the operating mechanism.

A lever and cam are provided on the regulating valve to permit opening the valve should it become necessary to change to hand regulation. A half turn of the bypass lever, to which is attached the cam *C* throws the valve wide open. For installations where the valve must necessarily be some distance from the operating floor, the sheave wheel *D* is added so that the valve can be opened by means of a cable from the operating floor.

The valve disks are made of a special hard bronze, monel metal or stainless steel as best meets the needs of the particular installation.

Regulators are available in sizes ranging from ½ to 12 inches. The regulating valve is furnished in the screwed type from ½ to 2½ in., inclusive, and in the flanged type from 1 to 12 in., inclusive. Globe valves can be furnished in all sizes, and angle valves from ½ to 4 in., inclusive.

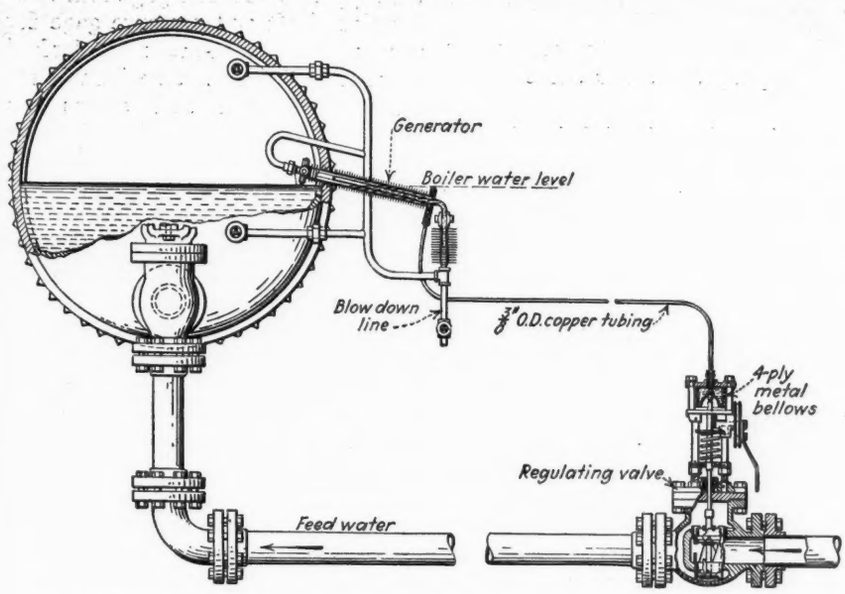
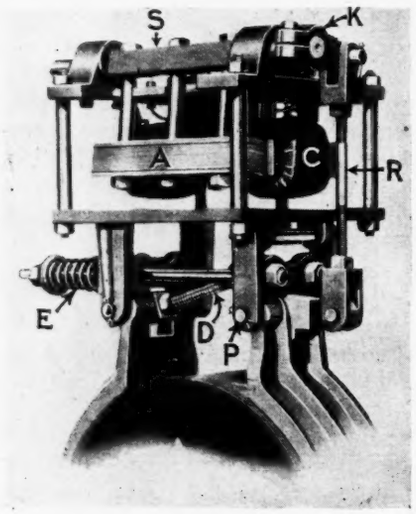


Fig. 3—Typical arrangement of pressure generator, regulating valve, and interconnecting piping

Alternating-Current Elevator Brake

ALTERNATING-CURRENT elevator brakes present many problems not encountered with direct-current types. Direct-current brake-magnet coils take the same current regardless of the position of the armature. An alternating-current magnet takes several times the current when the air gap is large as it does when the magnetic-circuit is closed. The action of an alternating-current magnet is generally more abrupt than is the direct-current type. On account of the pulsating pull produced by the alternating field, the magnet tends to be noisy if not properly designed and constructed.

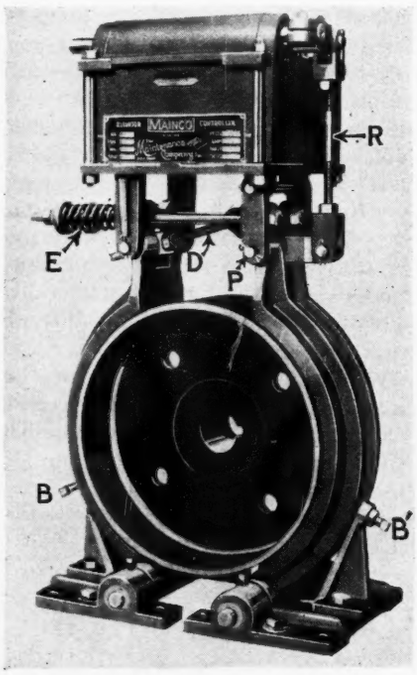
The figures show the new alternating-current brake recently placed on the market by The Maintenance Company, 449 West 42nd St., New York City. The operating mechanism is located above the brake shoes, where it is easy to get at for adjustment or repairs. This arrangement does not require a base for the brake and allows it to be installed where the brake wheel is near the machine's bed plate. By careful attention to the construction of the core and by rigid mounting of the different parts of the operating mechanism the magnet is quiet when energized, even when operating without the oil reservoir, as is frequently done. For extra quiet operation the brake magnet is immersed in an oid reservoir.



Brake operating mechanism

The magnet core is built up of high-grade laminated silicon steel and is of the three-legged form, with a coil *C* on each of the outside legs. The two magnet coils may be connected for single-phase, two-phase or three-phase operation. A rigid support for the magnet is made with the top of the frame. The armature *A* of the magnet is attached to a shaft *S* that is supported in two bearings having very close clearance. A crank *K* is mounted on one end of the shaft and is connected to the brake by the adjustable rod *R*. This rod connects to one end of a bell crank that is fulcrumed on pin *P* in the upper end of one of the brake shoes. The inside end of the bell crank is connected by the adjustable rod *D* to the other brake shoe.

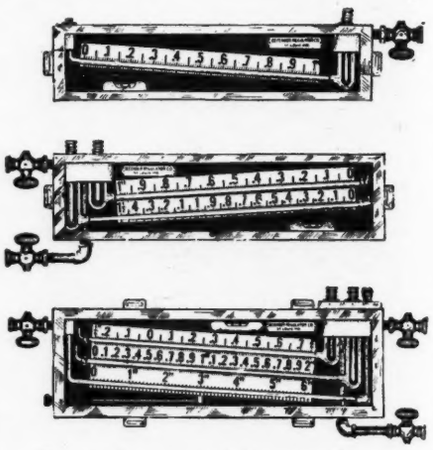
When the magnet is energized it pulls armature *A* to its core and transmits an upward motion to rod *R*. This motion through the belt crank causes rod *D* to move to the left and pushes the left-hand shoe away from the brake wheel and against the back stop *B*. Further movement of the armature lifts the right-hand shoe off the wheel. Backstops *B* and *B'* are not to limit the opening of the brake but to equalize the opening between the two shoes. Opening of the shoe is adjusted by the nuts on rod *D* and the shoes should open only sufficiently to clear the wheel. Pressure of the brake shoes on the wheel to give the desired stop is adjusted by the tension on helical springs *E*. The brakes may be obtained with or without the oil reservoir to operate on any of the standard voltages and frequencies and for any capacity elevator.



Brake magnet is supported on the top of the brake shoes

Single-, Double- and Triple-Tube Draft Gages

THE illustration shows the single-, double- and triple-tube draft gages included in an improved line of instruments now being put out by the Defender Automatic Regulator Company, St. Louis, Mo. In these gages each tube is connected to an all-metal one-piece oil chamber fitted with a hollow oil-filling and leveling displacement plunger, which facilitates the calibration of the gage. This oil chamber was illustrated and described in the July 9 number.



Gages for use with natural- and forced-draft stokers

The single-tube gage is designed for use with natural draft. It is made in a number of draft ranges from ¾ to 3 in., and with scales 7½ or 10 in. in length. It can also be furnished with a compound scale in the three-inch size. This same gage is also made in the duplex- and triple-tube type. The latter gage is a combination draft and pressure gage for use with forced-draft underfeed stokers. The top scale which is ten inches in length and shows the furnace draft up to one inch is made compound. The center scale is graduated for reading uptake draft up to two inches.

The lower scale shows the pressure in the wind box of the stoker and is graduated up to six inches. A scale reading up to eight inches can also be furnished. An important feature of this gage is the use of green liquid in the lower tube. This liquid is made exactly twice the weight of water permitting making the vertical oil chamber on this particular tube larger in diameter but the same height as the other chambers. The over-all dimension of the three-tube gage without petcocks is: length 16 in., height 5½ in. and thickness 1¾ inches.

FROM AMONG READERS' PROBLEMS

Conducted By L. H. MORRISON

REFRIGERATING PLANT FOR A HOSPITAL—*In the main building of our institution we have one large kitchen in which the cooking is done for about 800 patients and employees. Adjoining this kitchen is a refrigerator of fairly large dimensions. About 75 ft. east from this kitchen by the way of a corridor is a milk room in which about 700 lb. of milk and also butter are kept. About 100 ft. south from this main kitchen is a storeroom and butcher shop.*

We are contemplating an artificial refrigerating system for the butcher shop, the lower kitchen, and the milk room. Would you consider it cheaper to install and maintain a central brine system in a room adjoining, we will say, the lower kitchen, or would you consider it more economical both from the installation point and from the maintenance point to install separate cooling systems of the household type in the three places mentioned? R. A. S.

While the central plant will cost more to install, the maintenance should be less and the power consumption lower. You will have the advantage of freedom from possible leakage of the refrigerant into the rooms, which would be most objectionable in a hospital.

SUPERHEATED STEAM FROM VERTICAL BOILER—*In taking the temperature of the steam coming over from four Manning vertical fire-tube boilers, we find that the thermometer registers 400 deg. F., although the saturation temperature of steam at the boiler pressure of 150 lb. gage is 366 deg. F. Is the thermometer reading correctly?* J. C. K.

The Manning vertical boiler has its water level several feet below the top of the tubes. Steam leaving the water surface comes into contact with the upper end of the tubes and is superheated to some degree. It is reasonable to assume that the thermometer is registering the correct temperature.

There is a prevailing belief that when steam is in the same vessel as water that the steam must have the same temperature as the water, that is, the saturation temperature. This is true only as long as there is no flow. As soon as the steam starts to flow away from the water surface it can become superheated.

BOILER FEED TREATMENT—*Please give a list of materials and apparatus necessary for the titration of boiler feed water, together with instructions and formulas for the chemicals to be used.* C. C. B.

This is too extensive to answer here. I suggest you purchase a copy of Powell's "Boiler Feed Water Purification" published by the McGraw-Hill Book Company. This covers the entire subject.

SMOOTHING ELEVATOR GUIDE RAILS—*What effect has sulphur mixed with oil on elevator guide rails? It certainly does away with the annoying scraping sound.* A. P.

The sulphur in the oil will do just what you found it to do; namely, clean up the surface of the rails and guide shoes. After this has been accomplished the guide rails, guide shoes and safeties under the car should be thoroughly cleaned with kerosene and then well lubricated. The lubrication of these parts should be done periodically, at such intervals as will keep the equipment in good working condition. For lubricating the guide rails, automatic lubricators have come into extensive use.

STOPPING COMPOUND ENGINE—*I would like some advice on the proper method of stopping a 750-hp. tandem-compound Corliss engine by the wrist-plate rocking bar. The engine has separate steam and exhaust eccentric rods. I have no trouble stopping a simple, single eccentric Corliss at any point in the stroke, but I cannot get the "hang" of the tandem engine, usually getting it on dead center. Would you recommend the placing of marks for "Stopping points," to be used when the crank-pin is enclosed?* E. S.

The difficulty is probably due to the fact that the high-pressure wristplate is being unhooked and barred. While this is being done, the exhaust from the high-pressure cylinder is flowing into the low-pressure cylinder, and the pressure exerted on this larger piston is sufficient to move the engine even though the high-pressure admission valve be closed. If the design permits, both the high- and the low-pressure wristplates should be manually operated simultaneously. Marking the flywheel should help.

FEED-WATER CHEMISTRY—*What are the meanings of the terms "Ph" and "p.p.m." use in discussing feed-water treatment?* B.F.K.

The term "p.p.m." means parts per million, that is, the term 2 p.p.m. would be used if a feed water had 2 grams of foreign matter per million grams of water.

The terms "Ph" is a little more difficult to explain. It refers to the hydrogen ion content of a water. If, for example, there is one gram of hydrogen ions per million grams of water, the ratio is $\frac{1}{1{,}000{,}000}$ or 10^{-6}, so the Ph is called 6, this being the exponent with the sign changed. If there were 1 part of hydrogen ion to 100,000,000 of water the ratio is $\frac{1}{100{,}000{,}000}$, which can be written 10^{-8}, and the concentration would be spoken of as Ph 8.

OIL IN DIESEL AIR TANKS—*We find that interior of the air-storage tanks on our Diesel engine is coated with oil. How can this be removed?* G. C.

The best way is to remove the pipe connections and put in a solution of water and lye. After the oil has been removed, blow out with air. To avoid oil deposits, feed less oil to the air compressor.

PREVIOUS QUESTION

DISCUSSED BY READERS

THE QUESTION

CAN a 10x12-in. steam engine be run on oil at 100 lb. gage? What adjustments are needed? P. M.

ALTHOUGH there is little precedent for running a steam engine on oil under pressure, there is no reason why this cannot be done. Reciprocating water motors of surprising power and speed were quite commonly used for washing machines and churns before electric motors pre-empted this field.

Nevertheless, it must not be presumed that a 50-hp. high-speed steam engine can be converted into a 50-hp. oil-pressure motor simply by feeding oil at steam pressure to the engine intake. Several adjustments are required.

Specifically, the 10x12-in. steam engine in question normally would run at a piston speed of about 800 ft. per min., or about 400 r.p.m. Assuming a boiler pressure of 100 lb. gage, the mean effective pressure for a small high-speed engine of this type would be about 60 lb. and the brake-horsepower would be about 95.

When operated as an oil-pressure motor, even with the same admission pressure of 100 lb., the piston speed

cannot safely be allowed to exceed that of the equivalent pump handling oil of the same viscosity. Steam has an internal viscosity of practically zero, and can be shot through the engine valves at a speed of over two miles a minute, with a pressure drop of only one or two pounds per sq.in. Oil has a viscosity ranging from 100 to 2,000 seconds Saybolt Universal, which greatly limits the allowable velocity through the valves, hence the oil motor's speed and power. Assuming the oil in question to have about the viscosity of fuel oil or light lubricating oil, the piston speed should not exceed 100 ft. per min., or 50 r.p.m. However, there is no expansion of the operating fluid with an oil motor, so that an admission pressure of 100-lb. gage should give a mean effective pressure of 90 lb. for a reasonable piston speed. Therefore, the same 10x12-in. engine operated as an oil-pressure motor would give about 19 boiler horsepower.

Such a motor must be arranged with a cut-off at all loads not less than 85 per cent of full stroke, preferably 95 per cent, and must be governed by throttling, not by cut-off variation. Air chambers should be provided for both the admission and exhaust lines, as near the cylinder as possible, each chamber being about the size of the cylinder.

It is evident that such a motor could not be used for driving an electric generator or other machine requiring steady speed, unless provided with an impracticably large flywheel. However, it could well be used to drive a conveyor or pump, and might be economically advantageous where oil under pressure would otherwise have to be throttled idly to a lower pressure.

ROBERT E. BRUCKNER.
Phillipsburg, N. J.

WHEN a steam engine is to be run on oil at 100 lb. pressure it is necessary to understand the difference in performance characteristics between oil and steam.

When steam is used to drive an engine, its characteristics of expansion and compression are exploited to get improvements in efficient operation. In order to do this, the inlet valve is closed before the end of the power stroke and the steam is expanded to a lower pressure for the remainder of the stroke, which action extracts energy from the steam. Again, on the exhaust stroke, the exhaust valve is closed before all of the steam has been cleared from the cylinder, so that compression takes place until the pressure increases to approximately the initial pressure.

When oil is to be used the valves will have to be set to admit oil for the full stroke and exhaust for the full stroke also, as the oil is practically unexpandable and non-compressible, an attempt to shut either inlet or exhaust valve before a complete stroke would stall the engine.

For this reason the indicator diagram of an oil-driven engine will be approximately a rectangle, and the use of the ordinary "D" or other valves usually found on steam engines will be impractical, as the engine would require unusually exact and quick valve action to prevent stalling or blowing out of a cylinder head. In fact, in order to insure against these troubles, the cylinder should be equipped with a relief valve.

R. S. LANE,
Assistant Mechanical Engineer
Interborough Rapid Transit Co.
New York City.

OIL is a non-compressible and relatively viscous fluid, so to operate an engine designed for steam on oil pressure, these properties must be allowed for. All valve recurrences must be retimed. Since oil is non-expansive the admission valve must be adjusted to enable the cylinder to take oil for the full stroke. The exhaust valve must remain open during the entire exhaust stroke or the oil trapped in the clearance space will stop the piston or burst the cylinder. No data is given concerning the type of valves this engine uses, but the dimensions indicate that it is probably either a four-valve non-releasing or an ordinary slide-valve engine.

If the machine is of the four-valve non-releasing double-eccentric type, set the steam eccentric exactly 90 deg. ahead of the crank and adjust the steam valves to zero lap. The exhaust valves should be set with slight negative lap and the eccentric rotated back until the valves close late enough to prevent compression.

In case the engine uses a slide valve, it will be necessary to cut away all of the steam lap and a little more than all of the exhaust lap from the valve to permit the ports to be open for full stroke. The variable cut-off shaft governor, with which the engine may be equipped, depends for its effect upon the expansive property of steam and so cannot operate with a solid-pressure medium. It must be bolted solidly in full-load position and a throttling governor installed in the feed header, perhaps in the space the steam separator occupied. The engine must be operated at a greatly reduced speed, because the friction of the oil passing through the valves is much greater than if steam were used. The wire drawing of the oil during the time the piston is near its limit of travel would materially reduce the cylinder pressure if normal piston speed were attempted.

At best the operation of such a makeshift would be far from satisfactory and the cost of the changes to valves and the throttling governor, which would have to be purchased, in most cases would make it appear that a hydraulic turbine would more than justify its additional cost in such a situation.

LEE MARSTELLER.
Springfield, Ohio.

A Question For Our Readers

HOW can we obtain clean steam for dye vats from the exhaust of our reciprocating engines?

P. S. W.

Suitable answers from readers will be paid for and published in the Aug. 27 issue.

THE answer is yes, of course, but a second question comes up: "Why run an engine on oil?"

The only place where this would be of advantage would be where oil is coming from a well at high-pressure, to be dropped into an open tank. Hence there would be no objection to getting some power out of the oil. But the engineer had best bear in mind the shocks that will occur when the oil starts flowing at the beginning of each stroke. Air chambers will be necessary, and likewise the slide valve must be made with no lap, as in the case of a steam pump, and the eccentric must have no angle of advance.

But it will run, for most oil meters are, in principle, piston engines.

The question, however, may be taken to illustrate the enginer's usual method of thinking. No details are given as to where the oil is coming from, what is being done with the oil at present, why it is desired to run the engine on oil, or what is to be done with the oil after used in an engine. In fact, there is less information than is contained in the usual letter written to the free medical adviser on a newspaper staff. That the engineer did not appreciate the necessity of giving details indicates to me that he grasps too little of the subject to undertake the adaption. My advise to him is that he forget it.

JOHN CASSIDAY.
Jersey City, N. J.

NO, I certainly do not think the engine will run on oil. In the first place, the oils lack the expansive powers of steam. The engine would not develop its power, if it turned over at all. In the second place, the oil would have to be admitted for the full length of the stroke and pumped out on the exhaust stroke.

EDGAR P. WANNER.
Lancaster, Pa.

I AM quite certain that a steam engine can be run on oil. I had a 6x8-in. double-cylinder *D*-valve engine on a mine hoist, which ran on 90 lb. water pressure. At first it was a failure, but I set the eccentric back and cut off the exhaust lap to take away all the compression.

The hoist at its best was inefficient and would do as a makeshift only.

Salt Lake City, Utah. L. T. STUART.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

New Power Development Announced for Industrial Chicago

Industrial Power Corporation Organized to Furnish Electricity, Gas and Steam for Industrial Use, Will Have Low-Temperature Carbonization Plant

ANNOUNCEMENT was made July 23 of the organization of the Industrial Power Corporation, which has been incorporated under the laws of Delaware, for the processing of coal and the furnishing of electrical power, gas and steam to the manufacturing and stockyard district of Chicago, including Packingtown and the entire industrial area adjacent. From a source intimately identified with this new development it has been learned that the new project is the culmination of twelve months' intensive engineering survey of the power requirement of this area.

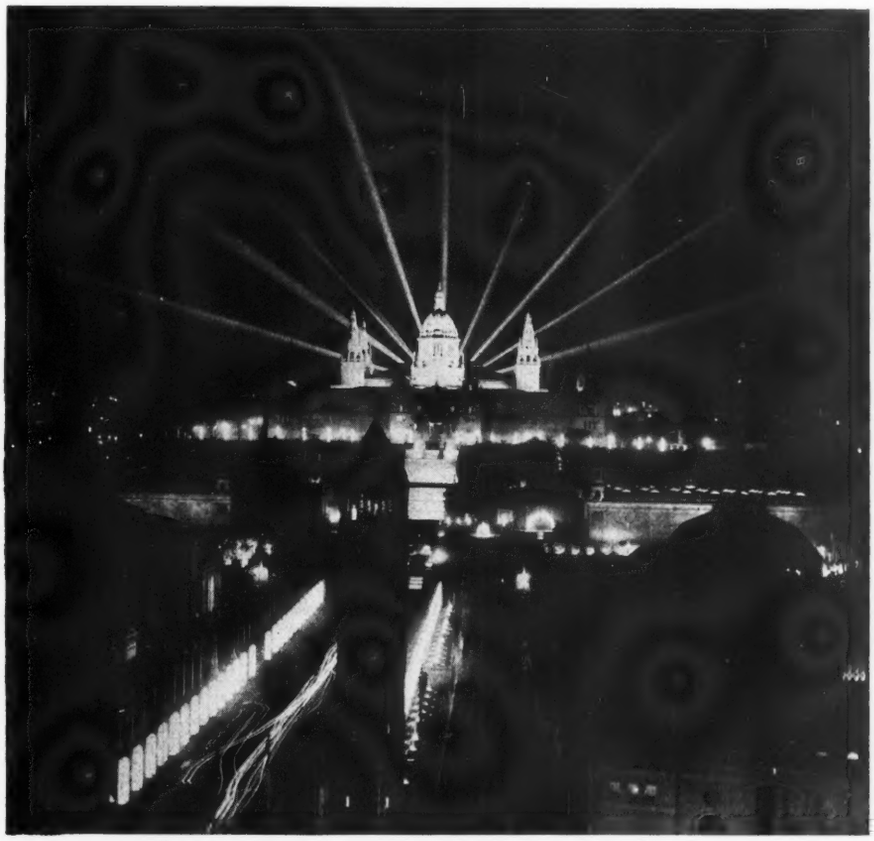
The physical properties of the new company will include a central station power plant having approximately 100,000-kw. capacity and designed for an ultimate steam plant of twelve 25,000-sq.ft. high-pressure boilers. The fuel for this central station will be secured from a coal-processing plant in which all of the fuel used in the new development will be treated by low-temperature carbonization to extract its more valuable constituents before the remaining solid fuel is realized for power development and for domestic use. This low-temperature carbonization plant will employ the same process of low-temperature carbonization that has been in commercial use in Europe for the past five years and was adapted to American practice by the coal-processing plant now in operation at New Brunswick, N. J., which plant is furnishing 3,500,000 cu.ft. of city gas daily to the Public Service Corporation of New Jersey.

The carbonizing plant at Chicago is designed for an ultimate capacity of 45,000,000 cu.ft., all of which will find a ready market in the industrial area adjacent to the property. The gas from this process is of especially high heating value and may be used directly for process work or blended with cheap blue gas to meet the requirements of standard city gas. The industries to be served by the plants of the new Industrial Power Corporation are now burning over 5,000 tons of coal per day in small isolated plants distributed throughout this industrial area. The centralization of the power and steam requirements of these industries will effect tremendous savings in both fuel, labor and investment costs, which will be reflected in a reduction in rates of electricity, gas and steam for processing in their plants.

The properties acquired by the new corporation include extenive areas with frontage on the Chicago River. Thus an adequate water supply and dock facilities are assured. The location is a particularly fortunate one, as it represents the geographical and industrial center of Chicago. Rights of way of streets have been secured and easements along the entire lines of the Chicago Junction Railway are included in the assets of the new company. These easements provide immediate access to 25 of the 26 railways entering Chicago. The imminence of electrification of railways entering the metropolitan area gives significance to the acquisition of these easements.

The new company has acquired outright the Produce Terminal Corporation, an Illinois utility, which has been in successful operation for many years but which because of the inadequacy of the plant has been able to furnish only a limited amount of electrical power and steam for processing to the plants in the stock yards district. The properties and contracts of the Produce Terminal Corporation accrue to the new company.

The development is of unusual significance, as it represents the first comprehensive combination of coal-processing with the generation of electrical current, the production of gas and the manufacture of domestic fuel. The immediate results of the activities of the Industrial Power Corporation should effect the growth and extension of the industrial and manufacturing development of Chicago. The reduction of gas and power rates will be reflected in manufacturing costs. Much valuable property now occupied by small power



THE SPECTACULAR lighting effects shown in this photograph, said to be the most marvelous in the history of lighting, were achieved by engineers of the Westinghouse Electric & Manufacturing Company for the International Exposition in Barcelona.

plants and coal storage will be released for manufacturing purposes by the centralization of power development.

Valuable coal derivatives are secured by low-temperature carbonization. These include tar, light oils, motor spirits and a solid fuel which is dense in structure, absolutely smokeless and well suited to either industrial or domestic use. Contracts have been entered into for the sale of tar, light oils and motor spirits, so that a ready market is assured for all of the products of the carbonizing process.

Stevens & Wood, utility engineers, are at present completing the survey of the properties to be served by the new development and are preparing plans for the new central station and the low-temperature carbonization plant, with the necessary provisions for combining the properties into a self-maintained system. Work on the new plants will be started at once. The present schedule provides for delivering service to the Chicago industrial area early in 1930.

The Industrial Power Corporation has secured exclusive state rights in Illinois, Indiana, Minnesota, Missouri, Michigan and Wisconsin to certain processes for the low-temperature carbonization of coal, and it is anticipated that the activities of this company will be extended in the near future beyond the area included in the initial development.

A.S.A. and Bureau of Standards Ratify Agreement

A co-operative agreement between the American Standards Association and the United States Bureau of Standards was ratified by George K. Burgess, director of the Bureau of Standards, and by the board of directors of the American Standards Association, July 9, at the board's first meeting. Under the terms of the agreement with the Bureau of Standards, the primary effort of the bureau will be to serve industrial groups having no satisfactory standardization facilities of their own. The American Standards Association will work primarily with those bodies having standardization facilities and will bring together such groups for the formulation of "American standards" representing a true national consensus of approval.

Bremen's Record-Breaking Power Plant Unusually Compact

New Steamer Has Twenty Oil-Fired Boilers, Four 30,000-hp. Turbine Sets and Many Auxiliaries Concentrated in Small Space

THE record-breaking trip of the North German Lloyd steamer "Bremen" again calls attention to the enormous power concentrated in the limited space assigned machinery in a steamship.

To drive the "Bremen" through the water at the rate of 28 knots the designers made use of four 30,000-hp. turbine sets, each powering a propeller. The sets consist of three turbines each, a high-, an intermediate- and a low-pressure, so placed on a single cast-steel frame that the three driving pinions mesh with the propeller gear at equally distant points, with the high-pressure turbine pinion in the top position. Two sets are arranged side by side, with the second pair in the compartment behind the first pair.

Steam at 327 lb. gage, with a total temperature of 660 deg. F., is supplied by twenty inverted V, or Yarrow, type water-tube boilers. These are arranged in front of the turbines, and consist of twelve double- and eight single-ended units, in rows of three, with the drums running fore and aft. The twelve double-ended boilers have 10,000 sq.ft. of heating surface each, and the eight single-ended ones have 5,000 sq.ft. each.

Each boiler has seven mechanical-type oil burners per front. Bunker C oil is stored between the ship's skins, and is heated before being forced by vertical double-acting, steam-driven pumps to the burners. The boilers are incased with removable steel plates, over which are packed asbestos pads.

Fresh water for the boilers is supplied by evaporators. The entire feed is handed from storage to the boiler by eight turbine-driven multi-stage centrifugal pumps, located in the turbine compartment below the floor grating.

The condensers are placed on the same level as the low- and intermediate-pressure turbines. Circulating water is handled by double-suction centrifugal pumps, placed immediately against each condenser and driven by turbines through reduction gears.

To supply current to the motor-driven auxiliary machinery four 580-kw. M.A.N., six-cylinder, four-stroke-cycle, solid-injection Diesels are placed aft of the turbines. They drive direct-current, inclosed-type generators. Fuel for these engines is carried in tanks distinct from the boiler oil tanks, as the German engineers do not believe that bunker C oil works satisfactorily in Diesels.

All control of the ship's electrical machinery is centered in the Diesel engine room. One end and parts of the two sides of the room are taken up by boards equipped with push-button controls and indicating lights.

To man the engine and boiler rooms, the "Bremen" has 160 engineers, oilers, firemen and helpers.

Spot * News

PLANS FOR DEVELOPMENT *by New York State of the South Sault Rapids in the St. Lawrence River as a huge water power project with an installed capacity of 1,000,000 hp. will be submitted to the Legislature at its next session, Governor Roosevelt announced July 24, after a survey of the proposed site.*

* * *

GERMAN LICENSES *for the manufacture of Loeffler "steam-pumping" boilers have been take out by Maschinenfabrik - Augsburg - Nürnberg, the well known Diesel engine concern in Augsburg, and by the Deutsche Werft, Hamburg.*

* * *

CREATION *of a single light and power company to serve Manhattan, Brooklyn, Queens, the Bronx and Westchester and linking of the steam-generating system of the New York Edison and affiliated companies with the hydro-electric system of the Niagara Hudson Power Corporation are among the plans being studied at present by engineers of the New York Edison Company.*

* * *

JUNE SALES *of mechanical stokers, as reported to the Department of Commerce by the ten leading manufacturers in the industry, totaled 203 of 67,322 hp., as compared with 174 of 60,772 hp. in May and 162 of 42,628 hp. in June, 1928.*

* * *

AT A RECENT MEETING *of the Kelvin Medal Award Committee the fourth triennial award of the Kelvin Medal was made to André Blondel, member of the French Academy of Sciences, for his work in electrical engineering.*

* * *

CONSUMPTION *of electricity in Great Britain increased ten per cent last year and has practically doubled during the last six years, according to information received by the Department of Commerce. A total of 7,602,000,000 kw.-hr. was used in 1928.*

* * *

THE POWER *of the Federal Trade Commission to subpoena as witnesses officials of the Electric Bond & Share Company was upheld by Federal Judge Knox in his recent decision on the case. The commission may not, however, demand inspection of the company's books.*

* * *

PRESIDENT COSGRAVE *pushed a button on July 22, which harnessed the lyrical River Shannon for the production of electric light and power to supply the Irish Free State. The completed project will have a capacity of 180,000 hp., but only about 120,000 hp. is in service at present.*

News of Canada

Boiler Inspection Unsatisfactory in Ontario—Expansion of Fertilizer Industry Contemplated

By Campbell Bradshaw
Toronto, Ont.

DISSATISFACTION with the system of boiler inspection in Ontario continues to be voiced by both power plant owners and operators. The work is handled by the boiler and factory inspection branches of the province's Department of Labor.

The construction and repair of steam boilers, to be operated in Ontario, must be approved by the boiler inspection department—an exceptionally capable government body, of which D. M. Medcalf is chief inspector, the rank and file, without exception being men thoroughly qualified to handle such work. Anyone who desires to build a steam boiler or other pressure vessel must, as already said, submit the design for approval. During construction the material is inspected, plate and stay steel examined and the work followed through until the final hydraulic test.

From then on, however, it is claimed, trouble is in the offing, for all control of the boiler in operation passes from the boiler inspection department to that of the factory inspector, whose staff, in no sense, claims to be qualified to determine the condition of a boiler, or the working pressure at which it should be operated. The proper work of this official, consists of seeing that safety devices have been installed, where necessary, on machinery, elevators, etc., and in determining whether or not the sanitary facilities of a plant are adequate. Apart from this routine, factory inspectors, and some of them are women, see that the certificate on the wall of the boiler room shows an inspection to have been made within a twelve months' period. Therefore, it is claimed by those who criticize the present arrangement that a boiler may be working under unsafe conditions in Ontario, with its operator, its owner and the government department qualified to look after its safety entirely unaware of it.

Expenditures estimated at $7,500,000 are contemplated in the next two years to build up a chemical fertilizer industry at Trail, B. C., and at the same time remove the deleterious element from the smelter gases, according to S. G. Blaylock, general manager of the Consolidated Mining & Smelting Company of Canada. Mr. Blaylock's statement follows that of Clark V. Savidge, State Land Commissioner, Olympic, Wash., intimating that the company's first unit will produce 35 tons of nitrogen a day, which means that a daily output of approximately 260 tons of ammonium phosphate is contemplated.

The total power consumption of a unit is estimated at 30,000 hp., an electrolytic hydrogen plant accounting for 23,000 hp. of this amount.

Men in the News

PAUL M. DOWNING,

vice-president of the Pacific Gas & Electric Company, San Francisco, in charge of elctrical operation and construction, has been named first vice-president and general manager of the company to succeed Frank A. Leach, Jr., who has retired, effective July 31. Mr. Downing is a pioneer in the electrical industry. He began his career as dynamo tender with the Tacoma Light & Power Company, Tacoma; was assistant motor inspector and power house operator for the Market Street Railway Company, San Francisco; and in 1897 became station superintendent of the power house at Blue Lake City, Calif., one of the first hydro plants in California.

Engineers' Committees Appointed to Shape Public Policies

Organization for 1929 of more than a score of committees to work with Congress and the Federal administration in shaping public policies involving vast engineering operations is announced by the American Engineering Council. Communications, flood control, safety of dams, water resources, and government reorganization are among the chief problems to be studied.

At a meeting of the council's administrative board to be held in Washington in October these committees will submit reports reflecting the engineering attitude toward legislation arising at the next session of Congress. With an engineer in the White House and with a growing representation of engineers in national, state and municipal public posts, the council has framed what is believed to be a most helpful program of co-operation.

D. Robert Yarnall of Philadelphia is chairman of the Public Affairs Committee. Public questions affecting engineers generally will come before this committee.

A new committee on communications has been named to study proposed legislation for Federal supervision of such mean of communication as radio, telephone and telegraph. This committee, headed by Edwn F. Wendt, of Washington, will study fundamental questions raised by the Watson and Couzens bills. Gardner S. Williams, of Ann Arbor, Mich., is chairman of a committee on flood control. Mr. Williams also heads committees on government reorganization and the safety of dams.

Chairmen of other committees of the council include: power, Farley Osgood, New York; recent economic changes, Dean Dexter S. Kimball, Cornell University; engineering and allied technical professions, H. C. Morris, Washington; program of research, Dr. Harrison E. Howe, Washington; patents, Edwin J. Prindle, New York; and national hydraulic laboratory, Farley Osgood, New York.

Three Mining Companies Install New Power Equipment

Three mining companies are modernizing their properties at the present time with the additions of new power and process equipment. Diesel-electric generating units, boilers, air-compressors and a large electric hoist have been ordered for their mines.

With the installation of an additional 3,750-hp. Nordberg unit, Commerce Mining & Royalty will have one of the largest Diesel power plants in the country at Cardin, Okla. The new six-cylinder engine will be direct connected to a 3,250-kva. generator and will increase the capacity of the plant to 10,500 hp.

Calumet & Arizona are installing two water-tube boilers of 7,500 sq. ft. each and a 750-kw. steam turbine with cooling towers. Besides adding two 4,400-cu.ft. air compressors to their plant, this firm is replacing its old steam hoist with a large electric hoist.

The Christmas Copper Mine at Christmas, Ariz., has just erected a new power plant, consisting of two 450-hp. CP Diesels and the foundation for a third. These engines are connected to 300-kw. generators, which supply power for the entire operation of the mine.

Diesel Engine Manufacturers Organize Association

With the rapid growth in the use of Diesel engines in all types of industrial, public utility and municipal service, the manufacturers of them have realized the need for a closer contact with each other and with the problems of the user. As a result, twelve of the leading builders, representing practically the entire output of Diesel engines in the United States, have organized the Diesel Engine Manufacturers Association. The association has as its pri-

mary object the advancement of Diesel power in America and a broad program of co-operation with the users of this type of power.

Possibly the greatest benefit to the users of Diesel power will come through the development of suitable standards of manufacturing and engineering practice. Such active problems as specifications for oil fuels, wider distribution of accepted fuels and similar subjects will have the attention of the manufacturers. More information will be made available on the application of Diesel engines in all types of service. Plant layouts will be studied with particular attention to cooling and lubricating systems.

The following manufacturers are members of the association: New London Ship & Engine Works, Electric Boat Company; Worthington Pump & Machinery Corporation; Fulton Iron Works Company; Ingersoll-Rand Company; Fairbanks, Morse & Company; Nordberg Manufacturing Company; I. P. Morris & De La Vergne, Inc.; Winton Engine Company; Cooper-Bessemer Corporation; McIntosh & Seymour Corporation; Busch-Sulzer Bros. Diesel Engine Company; and Hooven, Owens, Rentschler Company.

The president of the association is Henry R. Sutphen, president of the Electric Boat Company, E. T. Fishwick, vice-president of the Worthington Pump & Machinery Corporation, is vice president of the association, and Harlan A. Pratt, manager of the oil and gas engine department of Ingersoll-Rand Company, is secretary and treasurer. The association also employs M. J. Reed as research engineer, with headquarters at the association office, 30 Church St., New York City.

McKenzie River Basin Holds Much Potential Power

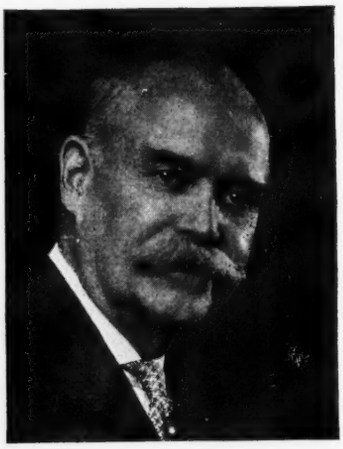
Water-power resources totaling 442,000 hp. for 50 per cent of the time and 289,000 hp. for 90 per cent of the time are available in the McKenzie River Basin, in Oregon, according to a statement made public by the Department of the Interior on the basis of a report prepared by Benjamin E. Jones, hydraulic engineer, and Harold T. Stearns, geologist.

Only 4,300 hp. is now being developed by the municipal plant of Eugene, Ore. A second plant is nearing completion near Leaburg. It will have an initial capacity of 10,000 hp. and an ultimate capacity of 20,000 hp. It is estimated in the report that if all the sites in the McKenzie River Basin were developed and interconnected with a large power system, with steam stand-by to carry the load in dry seasons, the total usable power would equal twice the present requirements of the State of Oregon. Electrochemical, electrometallurgical, or other industries requiring large amounts of power offer the only possibility for early development of these great resources, according to the report.

Thomas E. Murray Dies

Thomas Edward Murray, inventor, power plant designer and organizer of public utility companies, died of heart disease at his home in Southampton, L. I., July 21. He was 68 years old.

Second only to Thomas A. Edison in the number of his inventions, Mr. Murray was granted more than 1,100 patents. His inventions covered almost every phase of power generation and distribution, electrical and gas appliances, and welding. Innumerable features of modern power plant design



Thomas E. Murray

were introduced by him, among which the water-cooled furnace and a method of sluicing ashes in large plants are outstanding. His electrical inventions include many switching and protective devices. An electric welding process of his made possible high-speed production in the automobile and a score of other industries. It was due to another of his welding processes that the government was able to manufacture 240 mm. mortar shells during the World War.

Mr. Murray is believed to have designed more electrical power plants than any other man. Among these were the Brooklyn Edison Company, the Hell Gate station of the United Electric Light & Power Company and the $50,000,000 power plant of the New York Edison Company, three of the largest generating plants in the world.

Mr. Murray's first job was in the water works in Albany. Forty-five years ago he was placed in charge of it. Later he took charge of the Albany Municipal Gas Company. He was an expert engineer, machinist and an inventor, and due to these qualities he was selected by Anthony N. Brady as one of his chief assistants. It was about that time that Mr. Brady started to acquire control of gigantic public utility enterprises.

While he was still a young man Mr. Murray was sent to New York by Mr. Brady to purchase all of the electrical franchises in New York and Brooklyn, and to reorganize them. He succeeded in purchasing all of the large companies in Brooklyn and merged them into the Edison Electrical Illumination Company of Brooklyn. This organization later became the Brooklyn Edison Company.

Mr. Murray was one of the original directors and organizers of the New York Edison Company and the United Electric Light & Power Company. Prior to his retirement last year he was in active charge of operation of all Edison companies in New York, Brooklyn and Westchester. He retained supervision over his own corporations until his death. His privately owned companies were the Metropolitan Engineering Company, the Metropolitan Device Corporation, the Murray Radiator Company and Thomas E. Murray, Inc.

Mr. Murray was awarded the Longstreth Medal of Merit from the Franklin Institute of Philadelphia for his electrical discoveries and the invention of many safety appliances.

OBITUARY

CHARLES ROSZAK, for many years manager of the French, Babcock & Wilcox Company, died suddenly at his home in Paris on June 27. He was 40 years old. Prominent in French power and industrial fields, Mr. Roszak received many honors. He was an officer of the Legion of Honor and the French Academy and was awarded the Croix de Guerre by both France and Italy. As a professor in L'Ecole Centrale des Arts et Manufactures, he played an important part in engineering education and was said to be a constant source of inspiration to those who studied under him. Among other French organizations, he was a member of the Central Commission on Prime Movers and the French Society of Civil Engineers.

SAMUEL M. KENNEDY, retired vice-president of the Southern California Edison Company, died July 18 at his home in Alhambra, Calif. Mr. Kennedy had been connected with the Southern California Edison Company for more than twenty years, having entered the organization in 1903 when the United Electric, Gas & Power Company was absorbed by the Edison company.

PERSONALS

HOWARD HARDING, mechanical engineer with the Rochester Gas & Electric Corporation, has been elected treasurer of the Rochester Engineering Society. He has been employed for some time on special problems relating to the production of steam and electricity.

FRANK E. WEYMOUTH, chief hydraulic engineer for the Los Angeles Department of Power and Water, has been named chief engineer for the Met-

ropolitan Water District in charge of construction of the Colorado River aqueduct. He will divide his time between the duties of the two offices.

J. W. PARKER, who is chief engineer and assistant to the general manager of the Detroit Edison Company, has been elected alumni trustee of Cornell University. Mr. Parker was graduated from Cornell in 1908, and has maintained close contact with his school since that time. He is a past president of the Cornell Club of Michigan.

V. M. F. TALLMAN has been elected chairman of the New England Central Station Association of Power Engineers. Harry B. Stearns of the New England Power Association was elected secretary-treasurer. Thomas D. Bond, of Charles H. Tenney & Company, Boston, was made chairman of the power committee of the New England Division of the N.E.L.A. and J. H. Jackson, of the Public Service Company of New Hampshire vice-chairman.

M. BARRY WATSON, of Toronto, Canada, has recently resigned as director of engineering at the Central Technical School to associate himself with Harry Angus in engineering design work.

W. D. HAWKES was recently elected president of the Salt Lake Chapter of the National Association of Power Engineers. Others elected to offices were Edgar F. Bailey, John T. Caley, C. E. Chapman, J. P. Quigley and J. S. Durant. G. W. Nourse, retiring president, was named trustee. Mr. Hawkes and Mr. Quigley were chosen delegates to the national convention at Nashville, Tenn.

BUSINESS NOTES

EVANS ELEVATOR EQUALIZER COMPANY, INC., of Bedford, Ind., announces the opening of its general sales offices in the Chanin Building, 122 East 42nd St., New York City.

WESTINGHOUSE ELECTRIC ELEVATOR COMPANY announces the purchase of the Norton-Blair-Douglass Company, of New York City, manufacturers of electric signals and electric and manual door operators for elevators.

TIMKEN ROLLER BEARING SERVICE & SALES COMPANY has just made several changes in its organization. R. C. Brower has been promoted from general manager of that company to assistant secretary and assistant treasurer of the Timken Roller Bearing Company. W. H. Richardson, formerly manager of the New York branch of the service and sales company, has been made its general manager, with headquarters in Canton, Ohio. E. H. Austin, formerly manager of the Kansas City branch, will become manager of the New York branch.

Coming Conventions

American Institute of Electrical Engineers. Pacific Coast Regional Meeting, Santa Monica, Calif. Sept. 3-6. F. L. Hutchinson, secretary, 33 West 39th St., New York City.

American Welding Society. Fall meeting at Cleveland, Ohio, Sept. 9-13. Secretary, M. M. Kelly, 33 West 39th St., New York City.

National Association of Power Engineers, 47th annual convention, Chattanooga, Tenn., Sept. 9-13. Fred Raven, secretary, 417 South Dearborn St., Chicago, Ill.

National Association of Practical Refrigerating Engineers. Twentieth annual convention at the William Penn Hotel, Pittsburgh, Pa., Nov. 4-7. Secretary, E. H. Fox, 5707 W. Lake St., Chicago, Ill.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

Universal Craftsmen Council of Engineers. Annual meeting in Detroit, Mich., Aug. 6-10, at the Book-Cadillac Hotel. Grand Secretary, T. H. Jones, 33 Linden Ave., Cherrydale, Va.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

TRADE CATALOGS

SWITCHING EQUIPMENT — Several bulletins on relays and switching equipment have recently been published by the General Electric Company, of Schenectady, N. Y. Bulletin GEA-970A describes the type PQ relays. Bulletin GEA-1105 describes undervoltage devices for manually or electrically operated oil circuit breakers. Bulletin GEA-86A describes single-phase directional overcurrent relays. Weatherproof switch houses are described in Bulletin GEA-782A, and Bulletin GEA-1138 deals with pillars for instrument mounting.

PUMPS—A bulletin of useful information, with miscellaneous tables, has been issued by the Chicago Pump Company. Data for determining capacities for various installations are valuable features, and tables for computing pipe friction, quantity of feed water required to supply boilers, and other practical problems are of decided value.

STOKER—The McClave Type SR underfeed stoker is described in a bulletin just issued by the McClave-Brooks Company, Scranton, Pa. The stoker, designed for boilers from 50 to 300 hp., has several special features, which are pointed out in the bulletin. A drawing of construction details is included in the pamphlet.

FEED WATER REGULATOR—Bulletin 82, descriptive of the Bailey thermo-hydraulic feed water regulator, has been released by the Bailey Meter Company, Cleveland, Ohio. The principles of operation, details of construction and a table for selecting proper sizes are contained in the publication.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard...	New York.....	$2.00 @$2.35
Kanawha.....	Columbus.....	1.25 @ 1.50
Smokeless.....	Cincinnati.....	1.75 @ 2.00
Smokeless.....	Chicago.....	1.75 @ 2.25
S. E. Kentucky...	Chicago.....	1.35 @ 1.60
Steam.....	Pittsburgh.....	1.55 @ 1.65
Gas Slack.....	Pittsburgh.....	1.00 @ 1.10
Big Seam.....	Birmingham...	1.50 @ 1.75
Anthracite (Gross Tons)		
Buckwheat.....	New York.....	$2.50@$2.75
Barley.....	New York.....	1.30

FUEL OIL

New York—July 25, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 5.25c. per gal.; 36@40 deg., furnace, tank-car lots, 6c. per gal.

St. Louis—July 16, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.4209 per bbl. or 42 gal.; 26@28 deg., $1.4709 per bbl.; 28@30 deg., $1.5209 per bbl.; 30@32 deg., $1.5709 per bbl.; 32@36 deg., gas oil, 4.276c. per gal.; 38@40 deg., distillate, 5.23c.

Pittsburgh — July 17, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5.5c. per gal.

Philadelphia — July 21, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.575@$1.625 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati — July 16, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5.25c. per gal.; 30@32 deg., 5.5c. per gal.

Chicago—July 15, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 85c. per bbl.; 30@32 deg., $1.00 per bbl.

Boston — July 22, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.3c. per gal. 28@32 deg., 5.4c. per gal.

Dallas—July 20, f.o.b. local refinery, 26@30 deg., $1.30 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Ark., Russellville—City is having preliminary plans prepared for the construction of a power plant and distribution system. Estimated cost $150,000. W. L. Winters, Merchants Bank Bldg., Fort Smith, Ark., is engineer.

Calif., Ione—State of California will receive bids until Aug. 15 for the construction of a dam, also installation of water lines and electric power plant to supply Preston School of Industry. Estimated cost $69,000.

Calif., Sacramento—L. B. Rouse, Pine Grove, has been granted permit for appropriating 8 cu. second ft. of water from middle fork of Mokelumne River here to develop 455 hp. Estimated cost $25,000.

Calif., San Francisco—City and County, is having plans prepared for the construction of a hydro-electric plant in connection with Hetch Hetchy power project. Estimated cost $1,000,000. M. M. O'Shaughnessy is city engineer.

Conn., Bridgeport—United Illuminating Co., 128 Temple St., New Haven, Conn., awarded contract for a 1 story, 145 x 175 ft. addition to generating plant at "Steel Point," to E. E. Bray Co., 62 Cannon St.

Ill., Chicago—C. A. Carlson, 4001 Sheriden Rd., awarded contract for masonry, etc. for a 20 story, apartment building including central refrigeration plant, high speed electric elevators, etc. at Dearborn and Maple Sts. Estimated cost $2,000,000.

Kan., Marysville—Kansas Power & Light Co., Topeka, will build a hydro-electric plant here. Estimated cost $200,000. Private plans.

Mass., Lowell—Lowell Electric Light Corp., R. Pike, Engr., 29 Market St., plans the construction of two transformer stations with equipment one at Blossom St. and other at Barker Ave. Private plans.

Mass., South Dartmouth (New Bedford P. O.)—E. H. R. Green, will build a power house at Round Hills. Estimated cost $40,000. Private plans. Work will be done by day labor. F. C. Taylor, 50 Middle St., Fairhaven, in charge.

Mich., Detroit—Dept. of Water Supply, 735 Randolph St., received lowest bid for the superstructure of a low lift pumping station at Waterworks Park, form Gallagher Fleming Co., 6500 Epworth Blvd. $62,529. H. Fenkell, 735 Randolph St., is engineer.

Mich., Lansing—Dept. of Water & Light, W. B. Kirby, Secy., plans addition to steam power plant at Moores River Park. Estimated cost $350,000. J. E. Woodwell, 501 5th Ave., New York, N. Y., is engineer.

Mo., St. Louis—H. C. Felter, 720 Chestnut St., will build a 16 story apartment building at 1440 Lindell St. Estimated cost $1,250,000. C. Odenwald, 3957 A. Tholozan Ave., is architect. Work will be done by separate contracts.

Neb., South Sioux City—City will receive bids until Aug. 2 for the construction of two pumping stations in connection with sewage treatment work. Estimated cost $110,000. W. E. Buell Co., Insurance Exchange Bldg., Sioux City, Ia., is engineer.

N. J., Oradell—Bergen County, M. Harkness, Clk., Hackensack, will receive bids until Aug. 19 for the construction of a central heating plant here. Estimated cost $150,000. C. V. R. Bogert, 210 Main St., Hackensack, is architect. H. R. Kent, 5 Fire Ave., Rutherford, is engineer.

N. Y., Central Square—Bd. of Trustees, will receive bids until Aug. 7 for installing water supply system including pump house, etc. W. T. Field Engineers, Inc., Watertown, are consulting engineers.

N. Y., Minerva—New York Power & Light Corp., subsidiary of Mohawk-Hudson Power Co., 126 State St., Albany, has been granted permit for extensions and improvements to electric light plant here.

N. Y., New York—United Dressed Beef Co., 770 First Ave., awarded contract for the construction of a boiler room, oil burning equipment, etc., to The Engineer Co., 17 Battery Pl. Estimated cost $40,000.

N. Y., New York—Chanin Construction Co., 122 East 42nd St., plans the construction of a 40 story hotel at 119 Central Park W. Estimated cost $16,000,000. Ball & Snyder, 138 Madison Ave., are structural engineers.

N. Y., New York—Hunter College, c/o E. H. Elliott, Park Ave. and 69th St., will soon receive bids for the construction of a power house, social building etc. at Jerome Park Reservoir and Goulding Ave. Estimated cost $800,000. Thompson, Holmes & Converse, 101 Park Ave., are architects. Kaiser, Muller & Davis, 101 Park Ave., are electrical engineers.

N. Y., Sullivan (mail Canastota)—Syracuse Lighting Co., 421 South Warren St., Syracuse, has been granted permit for extension of gas facilities for light, heat and power here.

N. Y., Utica—Shendoa Rayon Corp. awarded contract for the construction of a boiler house to Aberthaw Co., 80 Federal St., Boston Estimated cost $40,000.

N. C., Bryson City—Aluminum Co., of America, plans a large power development on Little Tennessee river and its tributories near here. Plans include three dams, making lake of Nantohala gorge and relocation of Fontana branch of the Southern Ry. Estimated cost approximately $15,000,000.

N. C., High Point—City will receive bids until Aug. 14 for the construction of a sewage disposal plant including low lift pumping station, etc. W. C. Olsen Inc., Raleigh, is engineer.

Oregon — Mountain States Power Co., 101 South 10th St., Tacoma, will build an addition to steam power plant, 10,000 kw. capacity, between Marshfield and North Bend. Estimated cost $1,150,000.

Pa., Philadelphia — Quaker City Laundry, 48th and Locust Sts., will soon award contract for the construction of a 2 story, 50 x 100 ft. laundry and power house at 4808-12 Market St.

R. I., Slatersville—Slatersville Finishing Co., is receiving bids for a 55 x 85 ft. boiler plant. C. T. Main, Inc., 201 Devonshire St., Boston, is engineer.

Tennessee—Holston River Power Co., Rogersville, has been granted permit by the State Railroad & Public Service Commission, Nashville, to develop three water power sites on the Holston River. Plans include three dams and three water power plants, one dam located at Kingsport, generating 30,000 hp. and third dam near Bluff City.

Ont., Ottawa—Dpt. of Public Works, S. E. O'Brien, Secy., will receive bids until Aug. 2 for the construction of a refrigeration plant at National Research Council Laboratory, Sussex and John Sts.

Equipment Wanted

Boiler—Bd. of Commissioners, M. K. Rickett, Auditor, Knox, Ind., will receive bids until Aug. 5 for removal of old boiler and installing new boiler in court house.

Boiler—Treasury Dpt., Office of Supervising Archt., Washington, D. C., will receive bids until Aug. 7 for new heating boiler, etc., at U. S. Post Office, Beloit, Wis.

Boilers—U. S. Veterans' Bureau, Construction Div., 764 Arlington Bldg., Washington, D. C., will receive bids until Aug. 6 for removal of existing boilers and installing complete 5 new boilers etc. at U. S. Veterans' Hospital, Aspinwall, Pittsburgh, Pa.

Engines—City of West Point, Miss., will receive bids until Aug. 7 for oil engines for proposed water and light plant.

Motors and Control Equipment—Bd. of Transportation, J. H. Delaney, Chn., New York, N. Y., will receive bids until Aug. 20 for motors and control equipment, also power equipment for Independent system of city subways.

Pump—City of Fort Scott, Kan., plans to purchase and install booster pump for proposed waterworks improvements. Estimated cost $15,000.

Pumping Equipment—Bd. of Transportation, J. H. Delaney, Chn., New York, N. Y., will receive bids until Aug. 2 for furnishing and installing pumping equipment at Chambers St. and Church St., Franklin St. and Church St., Canal and 6th Ave. ext. Minetta St. and 6th Ave. and Greenwich Ave., West 11th St. and Greenwich Ave., Mid-River pump room 53rd St. Tunnel line, and 53rd St. near 8th Ave. on Route No. 101, Sections Nos. 3, 4 and 5, and Route No. 104, Sections Nos. 1 and 3.

Pumping Unit—City of Ballinger, Tex., pumping unit for proposed waterworks and distribution systems. Estimated cost $70,000.

Pumps—City of Adrian, Mich., plans to purchase three 180 kva. motor driven centrifugal pumps, 3 ph., 60 cycle, 2,300 v. belted generator with belted exciter, for proposed waterworks.

Pumps, Etc.—Borough Council, W. H. R. White, Mayor, Red Bank, N. J., will receive bids until Aug. 5 for a deep well centrifugal pump, direct connected to motor, also booster pump, etc., for proposed waterworks.

Pumps, Etc.—City of Glendivve, Mont., plans to purchase one 40,000 and one 80,000 g.p.m. low duty pumps, etc. for proposed waterworks improvements.

Industrial Projects

Cal., Emeryville—CALCULATING MACHINE FACTORY—Merchant Calculating Machine Co., is having plans prepared for the construction of a 2 story factory on Powell St. Estimated cost $50,000. Miller & Warnecke, 1404 Franklin St., Oakland, are architects.

Calif., Oakland — GLASS PLANT — Atlas Glass Co. Ltd., represented by B. F. Woolner, Atty., First National Bank Bldg., is having preliminary plans for the construction of a glass plant. Estimated cost $250,000.

Conn., Beacon Falls—BRASS FACTORY—H. D. Bronson Co. is having plans prepared for the construction of a 2 story, 35 x 100 ft. factory for the manufacture of brass goods. Estimated cost $45,000. W. E. Hunt, 182 Church St., Torrington, is architect.

Conn., Hartford—SHEET METAL FACTORY—Liner-Atwell Co., 60 Bartholomew Ave., awarded contract for a 2 story, 50 x 100 ft. factory to Bartlett Brainerd Co., 252 Asylum St. Estimated cost $50,000

Mich., Detroit—RADIATOR FACTORY—Long Mfg. Co., 2768 East Grand Blvd., is having plans prepared for a 2 story, 128 x 400 ft. factory for the manufacture of automobile radiators, clutches and accessories on Dequindre St. Estimated cost $300,000. G. V. Pottle, 1801 David Whitney Bldg., is architect. Electric motors, etc., will be required.

Mass., Everett (br. Boston) — CHEMICAL PLANT—Merrimac Chemical Co., will build a 1 story, 60 x 130 ft. factory. Estimated cost $45,000. Private plans. Work will be done by separate contracts.

Mich., Ferndale—STEEL FACTORY—The Forging & Steel Corp., c/o Austin Co., 11-205 General Motors Bldg., Detroit, Contrs, will build a 1 story factory on Wanda Ave. here. Estimated cost $50,000. Equipment for the manufacture of tool steel will be required.

Mich., St. Joseph — AUTOMOBILE PARTS FACTORY—Auto Specialties Co., awarded contract for a 3 story factory for the manufacture of automobile parts to Owen-Ames-Kimball Co., 38 Pearl St. N. W., Grand Rapids. Estimated cost $750,000. Electric motors, electric furnace conveyor system and equipment will be required.

Mo., Maplewood — AUTOMOTIVE ACCESSORIES FACTORY—Sunnen Products Co., 6417 Dale Ave., St. Louis, will soon receive bids for a 1 story, 120 x 168 ft. factory for the manufacture of valve grinders, valve lifters, compressors and other automotive accessories at Manchester and Bartold Aves. here. Estimated cost $65,000. B. E. Elliott, Mexico, Mo., is architect.

O., Canton — FACTORY — Hercules Motor Corp., 140 Halliwell Pl., S. E., awarded contract for the construction of a 1 story factory at 11th St. S. E., to E. J. Landor Co., Renkert Bldg. Esimated cost $100,000.

O., East Liverpool—FOUNDRY PRODUCTS—Patterson Foundry & Machine Co. awarded contract for the construction of a 1 story factory for the manufacture of foundry products, to Potters Lumber Co. Estimated cost $150,000.

O., Youngstown—MACHINERY FACTORY—McKay Machine Co., R. L. Thomas, Treas., awarded contract for a 1 story, 34 x 104 ft. factory on Rayen Ave., to E. P. Linberger, 830 Market St. Estimated cost $40,000.

Pa., Philadelphia—RADIO MANUFACTURING PLANT—Atwater Kent Co., Wessahicken and Abbotsford Rd., plans the construction of a 1 story, 500 x 900 ft. radio manufacturing plant. Ballinger Co., 12th and Chester Sts., is architect.

Wis., Racine — STEEL FOUNDRY — Belle City Malleable Iron Co., awarded contract for a 2 story, 60 x 180 ft. steel foundry, to Nelson & Co., Racine.

B. C., New Westminster—PAPER PLANT—Westminster Paper Co. Ltd., plans the construction of a plant. Estimated cost $1,100,000.

Ont., Chatham—AUTOMOBILE WHEEL FACTORY—Hayes Wheels & Forgings Ltd., 240 Raleigh St., awarded contract for masonry, etc. for a 180 x 400 ft. addition to plant. Estimated cost $200,000.

Ont., Windsor—AUTOMOBILE FACTORY—Chrysler Corp. of Canada, 300 East Tecumseh Rd., is having plans prepared for the construction of a 1 and 4 story factory. Estimated cost $500,000. Hutton & Soutar, Hamilton, Ont., are architects. Electric motors, etc., will be required.